EKACF
1.8
10/01/08

Final Eka Chemicals, Inc.
Sampling and Quality Assurance Plan
Moses Lake, Washington

TDD Number 08-05-0005

October 2008

Prepared for:
United States Environmental Protection Agency
1200 Sixth Avenue, Mail Stop ECL-112
Seattle, Washington 98101

Prepared by:
ECOLOGY AND ENVIRONMENT, INC.
720 Third Avenue, Suite 1700
Seattle, Washington 98104

SAMPLING AND QUALITY ASSURANCE PLAN FOR:

Eka Chemicals, Inc.
Moses Lake, Washington

Contract Number: EP-S7-06-02
Technical Direction Document Number: 08-05-0005

Prepared By:
Jeff Fetters, Project Manager
Ecology and Environment, Inc.
720 Third Avenue, Suite 1700
Seattle, Washington 98104

Submitted To:
Brandon Perkins, Task Monitor
United States Environmental Protection Agency
1200 Sixth Avenue, Mail Stop ECL-112
Seattle, Washington 98101

Date: October 2008

Approvals

Title	Name	Signature	Date
EPA Task Monitor	Brandon Perkins	Brandon Pe[illegible]	10/5/2008
EPA Region 10 Quality Assurance Officer:	Gina Grepo-Grove	[illegible] for Ginna Grepo - Grove	10/9/2008
START-3 Project Leader:	Renee Nordeen	Renee L Nordeen	10-7-08
START-3 Project Manager:	Jeff Fetters	Jeff Fetters	10-7-08
START-3 Quality Assurance Officer:	Mark Woodke	Mark Woodke	10-7-08

SQAP and Final Report Distribution

Name and Title	Organization	E-Mail and Phone Number	SQAP	Final Report
Sharon Nickels, Project Officer	U.S. Environmental Protection Agency Seattle, Washington	nickels.sharon@epa.gov 206-553-6644		
Brandon Perkins, Task Monitor	U.S. Environmental Protection Agency Seattle, Washington	perkins.brandon@epa.gov 206-553-6396	X	X
Gina Grepo-Grove, QA Officer	U.S. Environmental Protection Agency Seattle, Washington	grepo-grove.gina@epa.gov 206-553-1632	X	
Bethany Plewe, Region 10 RSCC	U.S. Environmental Protection Agency Seattle, Washington	plewe.bethany@epa.gov 206-553-1603	X	
Dhroov Shivjiani, Program Manager	Ecology and Environment, Inc. Seattle, Washington	dshivjiani@ene.com 206-624-9537		
Renee Nordeen, Project Leader	Ecology and Environment, Inc. Seattle, Washington	rnordeen@ene.com 206-624-9537	X	X
Mark Woodke, QA Officer	Ecology and Environment, Inc. Seattle, Washington	mwoodke@ene.com 206-624-9537		
Jeff Fetters, Project Manager	Ecology and Environment, Inc. Seattle, Washington	jfetters@ene.com 206-624-9537	X	X

Table of Contents

Table of Contents (cont.)

Table of Contents (cont.)

LIST OF APPENDICES

List of Tables

List of Figures

Figure		Page

List of Abbreviations and Acronyms

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
BGS	Below Ground Surface
CLP	Contract Laboratory Program
COCs	Contaminants of Concern
DQI	Data Quality Indicators
DQOs	Data quality objectives
E & E	Ecology and Environment, Inc.
Ecology	Washington Department of Ecology
Eka	Eka Chemicals INC.
EPA	U. S. Environmental Protection Agency
ESA	Environmental Site Assessment
FOWP	Field Operations Work Plan
GPS	Global Positioning System
IDW	Investigation-derived waste
MTCA	Model Toxics Control Act
MS/MSD	Matrix spike/matrix spike duplicate
MEL	Manchester Environmental Laboratory
PO	Project Officer
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
RPD	Relative percent difference
RSCC	Regional Sample Control Coordinator
SI	Site Inspection
SIS	Sample Information System
Soiltest	Soiltest Farm Consultants, INC.
SOP	Standard operating procedure
SQAP	Sampling and quality assurance plan
START	Superfund Technical Assessment and Response Team
TDD	Technical Direction Document
TDL	Target distance limit
TM	Task monitor

1 Project Management

1.1 Project/Task Organization

This subsection outlines the individuals directly involved with the Eka Chemicals, Inc. (Eka) project and their specific responsibilities. Communication lines are shown in the Project Organization Chart (Figure 1-1).

1.1.1 United States Environmental Protection Agency, Region 10, Task Monitor

The United States Environmental Protection Agency (EPA) Task Monitor (TM) is the overall coordinator of the project and decision maker. The TM reviews and approves the site-specific sampling and quality assurance plan (SQAP) and subsequent revisions in terms of project scope, objectives, and schedules. The TM ensures site-specific SQAP implementation and is the primary point of contact for project problem resolution and has approving authority for the project.

1.1.2 EPA Region 10 Quality Assurance Officer

The EPA Region 10 Quality Assurance (QA) Officer reviews and approves the site-specific SQAP and revisions in terms of QA aspects and may conduct assessments of field activities.

1.1.3 EPA, Region 10, Regional Sample Control Coordinator

The EPA Regional Sample Control Coordinator (RSCC) coordinates sample analyses performed through the EPA Contract Laboratory Program (CLP) or the EPA Region 10 Manchester Environmental Laboratory (MEL) or both and provides sample identification numbers.

1.1.4 Ecology & Environment Inc. Superfund Technical Assessment and Response Team-3 Project Manager

The Ecology & Environment Inc. (E & E) Superfund Technical Assessment and Response Team (START)-3 PM provides overall coordination of field work and provides oversight during the preparation of the site-specific SQAP. The PM implements the final approved version of the site-specific SQAP and records any deviations and acts as the primary contact point with the EPA TM. The PM receives CLP/EPA Region 10 laboratory information from the RSCC, acts as primary START-3 point of contact for technical problems, and is responsible for the execution of decisions and courses of action deemed appropriate by the TM. In the absence of the START-3 PM, a START-3 site manager will assume the PM's responsibilities.

1.1.5 E & E START-3 Quality Assurance Officer

The Quality Assurance Officer (QAO) reviews and approves the site-specific SQAP, conducts in-house audits of field operations, and is responsible for auditing and reviewing the field activities and final deliverables and proposing corrective action, if necessary, for nonconformities.

1.1.6 E & E START-3 Program Manager and EPA Project Officer

The Project Officer (PO) is responsible for coordinating resources requested by the TM for this project and for the overall execution of the START-3 program.

1.2 Problem Definition/Background

Pursuant to EPA START-3 Contract Number EP-S7-06-02 and Technical Direction Document (TDD) Number 08-05-0005, E & E will perform a Site Inspection (SI) at the Eka site, which is located near Moses Lake, Washington. The SI will consist of limited sampling at potential contaminant source and target areas for site characterization purposes. This document outlines the technical and analytical approaches E & E will employ during SI field work. This document is a combined field operations work plan (FOWP) and site-specific quality assurance project plan (QAPP) for field sampling activities. The combined FOWP/QAPP, hereafter called the SQAP, includes a brief site summary, project objectives, sampling and analytical procedures, and QA requirements that will be used to obtain valid, representative field samples and measurements. The SQAP is intended to be combined with information presented in E & E's (2005a) quality management plan (QMP) for Region 10 START-3. A copy of the QMP is available in E & E's office located at 720 Third Avenue, Suite 1700, Seattle, Washington 98104.

This subsection discusses the site background (subsection 1.2.1), site operations and source characteristics (subsection 1.2.2), and site characterization (subsection 1.2.3).

1.2.1 Site Background

Information presented in this subsection is based on a review of site background information.

1.2.1.1 Site Location

Site Name:	Eka Chemicals, Inc.
CERCLIS ID Number:	WAN001002725
Site Address:	2701 Road N Northeast, Moses Lake, Washington 98837
Latitude:	47° 7' 35.166" North
Longitude:	119° 11' 35.937" West
Legal Description:	Township 19 N, Range 29 E, Section 21
County:	Grant
Congressional District:	4
Site Owner/Operator:	Eka Chemicals AB

Site Name:	Eka Chemicals, Inc.
	Lilla Bommen 1 Göteborg, Sweden
Site Contact:	Calvin Greene, Manager Eka Chemicals, Inc. 2701 Road N Northeast Moses Lake, WA 98837 (509) 765-6400

1.2.1.2 Site Description

The Eka facility is a wood products chemical manufacturing facility located in a business/industrial area east of Moses Lake, Washington (Figure 1-2). Land use in the vicinity of the site consists of mixed agricultural, commercial, and industrial uses. The property is bordered to the north by McKay Seed Company and further north by Washington Central railroad tracks and Wheeler Road. Agricultural land borders the property to the east and south and Road "N" borders the property to the west. The entire property consists of 110 acres of which 100 are currently used as farmland with the potential for facility use in the future and 10 acres are fenced and used for the manufacturing and transportation of chemicals. The property is approximately 1,221 feet above mean sea level. The topography is relatively flat and slopes generally to the southwest at a 1% grade. (LFR 2007)

The Eka facility contains a variety of buildings associated with paper production including the office and parking lot, chlorate process building, acid loading equipment, water cooling towers, sodium chlorate loading area, silos and tanks, the collection pond and paper chemicals process building (Figure 1-3).

1.2.1.3 Site Ownership History

The site is currently owned by Eka Chemicals AB of Goteborg, Sweden. Property ownership prior to 1990 is unknown; however the property appears undeveloped in 1956 and 1978 topographic maps (LFR 2007). Prior to 1990, the Eka property was farmland. Paper chemical manufacturing operations have been conducted at the property since 1990 (Jordan 2008).

1.2.2 Site Operations and Source Characteristics

Eka began operations at the site in 1990 producing only sodium chlorate. Shortly thereafter, the manufacture of a paper coating chemical (an alkyl-ketene dimer emulsion) was added. In 2004, the facility expanded with additional product lines which included a range of paper making agents and a wood laminate glue additive. The facility also offloads and reloads other paper chemical products for redistribution on the West Coast. (Ecology 2007)

The facility produces sodium chlorate for use as a bleaching agent in pulp and paper mills. Hydrochloric acid and sodium hydroxide are used and stored at the site. (LFR 2007)

Sodium chlorate is produced by electrolysis of an aqueous salt solution according to the following equation:

$$NaCl + 3H_2O \rightarrow NaClO_3 + 3H_2$$

Bulk salt (NaCl) is imported by rail. The salt is dissolved in water and purified by precipitation, filtration and deionization. The salt solution is then sent to electrolytic cells. Sodium chlorate is crystallized out of solution, washed, dried and shipped in bulk by rail and truck. (Ecology 2007)

Potential sources and typical storage amounts include sodium chlorate crystal and solution railcars (733 tons), sodium chlorate solution tanks (188 tons), and sodium chloride (150 tons). The railcars have no secondary containment and the sodium chlorate tanks have concrete secondary containment. The facility produces approximately 74,000 tons of sodium chlorate per year. Sodium chloride is brought to the facility by rail and trucks and is stored in 2,000 pound nylon storage bags. (Bingham 2008)

Discussions with onsite personnel indicated the occurrence of releases and/or spills in areas where chemicals are stored, mixed, and loaded or unloaded have occurred. (LFR 2007)

Two sodium chlorate spills have occurred at the facility since 1996. The July 1996 spill involved the release of approximately 5,000 pounds of solid sodium chlorate. Four 55-gallon drums of contaminated material (it is unknown if the drums contained product, soil or both) were removed and the remainder was left in place as the spill occurred near railroad tracks. The May 2007 spill involved the release of approximately 7,000 gallons of 46% sodium chlorate solution. Approximately 10 cubic yards of solids and approximately 330 gallons were removed from the spill area near the railroad tracks. The facility also had an explosion on December 29, 2007. The explosion primarily involved hydrogen and did not result in a release of hazardous substances or injuries. (Jordan 2008)

In 2007, the facility produced 44,000 pounds of waste sodium chlorate, 8,000 pounds of waste sodium chlorate solution, 2,450 pounds of laboratory waste, 950 pounds of waste methanol, and 218 pounds of waste paint-related materials. Much of this waste was generated when filtering the electrolytes used in the manufacturing process to remove iron. (Bingham 2008)

The potential contaminants of concern (COCs) at the site associated with these operations are sodium chlorate and perchlorate. Perchlorate is listed as a COC due to it being produced as an unintended byproduct from the manufacturing of sodium chlorate.

1.2.3 Previous Investigations

1.2.3.1 Chlorate Spill Soil Survey

Soiltest Farm Consultants, Inc. (Soiltest) of Moses Lake, Washington performed a Chlorate Spill Soil Survey in May 2007 (LFR 2007). The survey was performed to a maximum depth of three feet below ground surface (bgs) in the vicinity of the 2007 sodium chlorate spill. Soiltest found the presence of sodium, chloride, and chlorate in all soils tested, and concluded that the high solubility of the sodium chlorate and chloride salts were cause for concern regarding potential groundwater contamination. Soiltest recommended that deep core soil samples be obtained to establish the depth and rate of movement of the salts relative to groundwater elevations. (LFR 2007)

1.2.3.2 Modified Phase II Environmental Site Assessment

A Modified Phase II Environmental Site Assessment (ESA) was conducted in September 2007 to assess the presence or absence of potential COCs which included: sodium chlorate, chromium, lead, total petroleum hydrocarbons and chlorinated herbicides. These potential COCs were identified based on current or historical site usage. The investigated areas include the railcar loading/unloading area and the locations of the 1996 and 2007 sodium chlorate spills. The field activities of the Modified Phase II ESA soil sampling program were conducted on September 11, 2007. (LFR 2007)

A total of 21 soil samples were collected from sample depths ranging between 1 and 12 feet bgs from eight discrete locations. Sample locations are presented in Figure 2-1. Sample locations B-1, B-2, B-3 and B-5 were placed near the 2007 spill impact area, sample locations B-6 and B-7 were placed near the 1996 spill area, sample location B-8 was located near the acid loading/unloading area, and sample location B-9 was collected in the field east of the water tower and was considered a background sample. The samples were analyzed for sodium chlorate, chromium, lead and herbicides. Sodium chlorate was detected in all samples analyzed at depths of up to 12 feet below ground surface. Evaluation of the samples collected from individual borings generally shows a downward trend in concentration with depth, with the exception of boring B-2, which may be a reflection of its downgradient position from the original spill elevation. Borings B-3 and B-7 approached background concentrations at their deepest sampled interval. The remaining five borings reflected concentrations well above background (113 mg/kg, collected at B-9) at their respective deepest intervals, which ranged from six to twelve feet bgs. The highest concentrations of sodium chlorate were detected between the rails on either side of the sodium chlorate loading facility, in borings B-5 and B-6, reflecting the past two spill events. All areas directly associated with sodium chlorate handling are capped with concrete and asphalt, which will limit potential movement of sodium chlorate due to meteorological water (LFR 2007). Analytical results indicated that the potential COCs, including lead and chromium, were either not detected above the respective laboratory method reporting limits and/or were below Washington

Department of Ecology (Ecology) Model Toxics Control Act (MTCA) Method A Soil Cleanup Levels for Unrestricted Land Uses (Ecology 1989).

The shallow soil samples analyzed for petroleum hydrocarbons were obtained in graveled areas adjacent to railcar loading/unloading where a petroleum spill may have passed through surface material to underlying soils. (LFR 2007)

No MTCA soil cleanup level has been established for sodium chlorate. Based on site maps, the spill area is approximately 195 feet by 160 feet (31,200 square feet) in size. Groundwater was not encountered during the field investigation. The depth to ground water at the site is anticipated to be several hundred feet bgs, thereby reducing risk of potential groundwater impact due to sodium chlorate soil concentrations. (LFR 2007)

1.2.3.3 START Site Visit

EPA and START personnel conducted a site visit on February 14, 2008. Eka representatives included Jimmy Jordan, corporate health and safety officer from Columbus, Mississippi, and Lynn Bingham, Moses Lake health and safety officer. EPA and START personnel interviewed the Eka representatives then participated in a site walk. Appendix A provides photographic documentation from the site visit. The rail loading/unloading area, the retention/evaporation pond, and the irrigation water drainage ditch were the primary areas observed during the site walk. The loading/unloading area was the location of the 1996 and 2007 sodium chlorate spills. This area is primarily covered with concrete or rock due to the presence of the rail lines. All storm water from the 10-acre fenced property flows to the lined evaporation/retention pond. Evaporation is the primary means of reducing liquid in the pond; there are no outfalls from the pond. The irrigation ditch is located approximately 100 feet south of the fenced property and is the carrier for overflow irrigation water originating on farm land east of the Eka property.

1.2.4 Migration/Exposure Pathways and Targets

This subsection discusses the ground water migration, the surface water migration, the soil exposure, and the air migration pathways and potential targets within the site's range of influence.

1.2.4.1 Ground Water Migration Pathway

The target distance limit (TDL) for the ground water migration pathway is a 4-mile radius that extends from the sources at the site. Figure 1-4 depicts the groundwater 4-mile TDL.

Geologic Setting:

Moses Lake is situated within the Quincy Basin, a structural sub-basin of the central Columbia Plateau. The subsurface stratigraphy of the Moses Lake area is comprised of a thick series of broadly folded, Miocene-age flood basalt lava flows (collectively known as the Columbia River Basalt Group; CRBG) and interbedded sediments overlain by unconsolidated deposits of late Miocene to recent age. In the Moses Lake area, the uppermost layers of fractured bedrock are the Wanapum Basalt formation. The typical CRBG basalt flow is characterized by an uppermost fractured and vesicular flow top, a dense columnar and entablature jointed interior, and a glassy, rubbly, or pillowed flow bottom. The combination of a flow top and overlying flow bottom from two adjacent flows is called an interflow zone and is normally significantly more porous than the basalt interior. Regionally, the surface of the Wanapum Basalt is known to slope to the southwest, although local depressions or rises are known to exist. (Ecology 2003)

Throughout much of the Moses Lake area, the CRBG is overlain by the late Miocene to Pliocene aged Ringold Formation. Ringold sediments are comprised of lacustrine clay, silt, and fine sand. Sub-surface investigations indicate that the Ringold Formation pinches out approximately 1 mile to the east of the Crab Creek drainage. It is thought that the Ringold Formation is absent from the site area, ether it has pinched out or has been eroded.

Overlying the CRBG in the site area is a sequence of Pleistocene-age flood deposits. These glaciofluvial deposits associated with Missoula flooding are known as the Hanford formation. The Hanford formation is in general composed of massive to well stratified boulder to granule sized basaltic gravels, with lesser deposits of sand, silt, and non-basaltic gravels. Caliche fragments and coatings are present in the lower portions of the unit. (Ecology 2003)

Surface soils in the Moses Lake area are largely from the Ephrata and Malaga series. These soils are typically characterized by very deep profiles of well-drained to excessively well drained material formed on glacial flood deposits. The grain size profile with depth is normally characterized by a shallow-horizon gravelly sandy loam or cobbly sandy loam grading to deep-horizon extremely gravelly and cobbly coarse sand (Bain 1990; USDA 1984). Soil permeabilities are moderately rapid the upper horizon and rapid in the lower portion of the soil horizon. (Ecology 2003)

Average total precipitation in the vicinity of the site is 7.87 inches (WRCC 2007).

Aquifer System:
Ground water in the site vicinity is contained within densely layered basalt rocks and is part of a large system which covers a majority of east-central Washington. According to Ecology files, approximately 16 private and eight public water supply wells are located within a 1-mile radius of the site. Static water levels reported in these wells range from approximately 25 feet to 280 feet bgs. The closest private well for which there is data is located between 0.125 and 0.25 mile to the south-southwest of the site, with static water levels ranging from 260 to 340 feet bgs. Regional ground water flow is reported as south to southwest toward the Snake and Columbia Rivers. (LFR 2007)

The ground water hydrology of the Columbia Basin is defined by a complex multi-aquifer system comprised of formations and overburden deposits (Bauer and Hansen 2000; Whiteman et al., 1994). The Columbia Basalt Group and the Priest Rapids member of Wanapum Basalt were the two aquifers found on well logs in the area. In areas where the Ringold Formation is present, the finer grained sediments act as an aquitard, hydraulically separating groundwater in the flood deposits from groundwater in the basalt flows. Because it is thought that the Ringold Formation is missing in the site area, groundwater in the flood deposits can directly interact with groundwater in the basalt, creating an unconfined aquifer condition. (Ecology 2003)

The horizontal hydraulic conductivity of the flood deposits ranges from 2,800 to 28,000 feet per day, with average seepage velocities of 1,100 feet per day. These numbers reflect the course, open frame work of the sediments. Due to the course frame work of the flood deposits, the infiltration rates are considered rapid, with little attenuation capacity for pollutants. Model calibrated horizontal hydraulic conductivities for the uppermost basalt ranges from 15 to 120 feet per day. (Ecology 2003)

The nearest well is located 100 feet south of the fenced area of the facility. The well is labeled as City Well #17. The well is drilled to 1,240 feet bgs. The well is not screened; however, a casing was placed from 0 to 686 feet bgs. From 686 feet bgs to 1,240 feet the well is completed as an open hole (Ecology 2008). Based on this lithology, the START assumes a hydraulic conductivity of 10^{-3} centimeters per second.

Drinking Water Targets:

Groundwater within 4 miles of the site is used for drinking water. Ground water flow direction is believed to follow the surface topography from northeast to southwest.

The City of Moses Lake has a total of 17 municipal wells with 8,736 connections serving a population of 20,650 (WDOH 2007). All wells have a 100-foot wellhead protection area; therefore, the site is located within a wellhead protection area. Five of the 17 municipal wells (7, 11, 12, 17 and 18) are located within the 4-mile TDL (Figure 1-4). These wells have depths ranging between 568 and 1,240 feet bgs and pumping capacities between 910 and 2,000 gallons per minute.

The City of Moses Lake's water system is separated into six service zones. According to the City of Moses Lake Drinking Water Quality Report for 2007, portions of three of the water service zones (Central, Lakeview, and Wheeler) are located and draw water from with in the 4-mile TDL. Each of the service zones is served by a dedicated well or group of wells. Service zones and the wells that serve them within the 4-mile TDL are as follows:

- Central Zone – Well 7

- Lake View Zone – Wells11 & 12
- Wheeler Zone – 17 & 18

Even though water from the wells is not blended (i.e., each well serves a specific set of households), information regarding the number of connections served by each of the municipal wells in the TDL could not be obtained. The city did provide the number of meters for each zone; therefore, START apportioned each of the meters equally to each well within the zone. Each meter was then assumed to serve a single residence and therefore, multiplied by the average number of persons per household for Grant County, Washington (2.92). The number of people served by each well in a given service zone is provided in Table 1-4.

In addition, approximately 687 private drinking water wells are located within the TDL (Ecology 2008). Based on the average number of people per household of 2.92 for Grant County, it is estimated there are approximately 2,006.04 people that use ground water for drinking water from private wells (DOC 2001). Table 1-1 provides the number of individuals drinking ground water within the TDL.

Because Moses Lake, Washington, is served by municipal wells, it is assumed that ground water is used as an ingredient in commercial food preparation

1.2.4.2 Surface Water Migration Pathway

All surface water from the 10 acre fenced property flows to a lined evaporation/retention pond. Evaporation id the primary means of reducing liquid in the pond. There are no outfalls from the pond. The irrigation ditch is located approximately 100 feet south of the fenced property and is the carrier of overflow irrigation water originating on farm land to the east of the Eka property. Because all surface water flow from the site is contained in the evaporation/retention pond, the surface water migration pathway is not being evaluated as part of this investigation.

1.2.4.3 Soil Exposure Pathway

The soil exposure pathway is evaluated based on the threat to resident and nearby populations from soil contamination within the first two feet of the surface.

Site Setting and Exposed Sources:

Exposed contaminated soil is present at the site where the July 1996 spill occurred. The site is fenced and security cameras impede the accessibility of the public (E & E 2008).

Targets:

The site is an active paper chemical manufacturing that employs approximately 35 workers (Bingham 2008). There are no residences or day care facilities at the site. No commercial agriculture, commercial silviculture, or commercial livestock production or livestock grazing occur on an area of observed contamination. No terrestrial sensitive environments are located on an area of observed contamination.

Approximately 71 people are located within a 1-mile travel distance of the site. Population by distance ring is provided in Table x-x.

1.2.4.4 Air Migration Pathway

The air migration pathway TDL is a 4-mile radius that extends from the sources at the site (Figure 1-4).

Human Targets:
The distance to the nearest residence is approximately 0.67 mile. There are approximately 35 workers at the site. (Bingham 2008)

There are approximately 1,157 people that reside within the TDL (DOC 2001). Two schools are located within the air migration pathway TDL. The closest school, Chief Moses Junior High School, is located between 2 and 3 miles from the site and has a population of 840 students and 41 teachers. Lakeview Terrace Elementary School, which is located between 3 and 4 miles from the site, has a population of 391 students and 20 teachers. Population including students and workers is provided in Table 1-3. (NCES 2007)

Environmental Targets:
Commercial agriculture is present within 0.5 mile of the site. An estimated 551.45 acres of wetlands are present within the TDL (USFWS 2003). Wetland acreage by distance ring is presented in Table 1-3.

There are no Federally-listed threatened and endangered species or state listed threatened and endangered species listed with in the 4-mile TDL.

1.2.5 Areas of Potential Contamination

Sampling under the Eka SI will be conducted at those areas considered potential contamination sources and at areas that may have been contaminated through the migration of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-regulated hazardous substances from sources on-site.

Based on a review of background information, discussions with Eka representatives, and discussions with the EPA TM, the following areas or features have been identified for inspection under the Eka SI.

Sources:

- **Acid Loading Area:** Subsurface soil samples were collected to a maximum depth of 11 feet bgs by LFR in November 2007 and indicated the presence of sodium chlorate at significant concentrations with respect to background. This SI will assist in determining if the acid loading area is still a source of contamination. Probable potential contaminants of concern include sodium chlorate and perchlorate.

- **Sodium Chlorate Loading Area:** Since 1996 there have been two sodium chlorate spills in the sodium chlorate area. A release in 1996 released approximately 5,000 pounds of solid sodium chlorate and the 2007 spill released approximately 7,000 gallons of 46 percent sodium chlorate solution. At the time of the released, the rail cars had no secondary contamination. This SI will assist in determining if the sodium chlorate loading area is still a source of contamination. Probable potential contaminants of concern include sodium chlorate and perchlorate.
- **Storage Tanks and Silos Area:** Subsurface soil samples were collected to a maximum depth of 11 feet bgs by LFR in November 2007 and indicated the presence of sodium chlorate at significant concentrations with respect to background. These concentrations maybe attributed to the 1996 and 2007 spills, which occurred up gradient of this area. This SI will assist in determining if the storage tank and silos area is still a source of contamination. Probable potential contaminants of concern include sodium chlorate and perchlorate.

<u>Targets:</u>

- Contaminants from on-site sources may be migrating to groundwater. This SI will assist in determining if contaminants are impacting groundwater targets. Probable potential contaminants of concern include sodium chlorate and perchlorate.

1.3 Project/Task Description and Schedule

This subsection provides the project description (subsection 1.3.1) and proposed schedule (subsection 1.3.2).

1.3.1 Project Description

This subsection defines the objectives and scope for performing the SI activities at the Eka site. The main goals for the SI activities are as follows:

- Collect and analyze samples to characterize the potential sources discussed in subsection 1.2.3.3;
- Determine potential for off-site migration of contaminants;
- Provide the EPA with adequate information to determine whether the site is eligible for placement on the National Priorities List (NPL); and
- Document a threat or potential threat to public health or the environment posed by the site.

1.3.2 Schedule

The schedule for implementing the SI is intended to be used as a guide. Adjustments to the implementation dates and the estimated project duration may be necessary to account for variable unforeseen or unavoidable conditions that the field team may encounter. Examples include inclement weather, difficulties in accessing a sampling site, unforeseen site conditions, or additional time needed to complete a task. Significant schedule changes that arise in the field will be discussed with the TM at the earliest possible opportunity.

The START-3 is targeting September 29, 2008, as the period to conduct the SI field work, which is estimated to take 5 days, including travel time to and from the site. This period comprises 0.5 day of mobilization, 0.5 day of demobilization, and 5 day to complete field activities. Work will be conducted during daylight hours only. The proposed schedule of project work is provided in Table 1-5.

1.4 Quality Objectives and Criteria for Measurement Data

The project data quality objectives (DQOs) are to provide valid data of known and documented quality to characterize sources, to determine off-site migration of contaminants, to determine whether the site is eligible for placement on the NPL, and to document threat(s) or potential threat(s) to public health or the environment posed by the site. The DQO process applied to this project follows that described in the document *Guidance for the Data Quality Objectives Process* (EPA 2000). See subsection 2.5 for a detailed measurement criteria discussion.

1.4.1 DQO Data Categories

All samples collected under this SQAP will be analyzed using definitive analytical methods. All definitive analytical methods employed for this project will be methods approved by the EPA. The data generated under this project will comply with the requirements for this data category as defined in *Data Quality Objectives Process for Superfund* (EPA 1993).

1.4.2 Data Quality Indicators

Data quality indicators (DQI) representativeness, comparability, completeness, precision, and accuracy goals for this project were developed following guidelines presented in the EPA *Guidance for Quality Assurance Project Plans*, EPA QA/G-5 (EPA 2002a).

The basis for assessing each of the elements of data quality is discussed in the following subsections. Subsection 2.5 presents the QA objectives for measurement of analytical data and quality control (QC) guidelines for precision and accuracy. Other DQI goals are included in the individual Standard Operating Procedures (SOPs) in Appendix B and in the Laboratory Statement of Work (SOW).

1.4.2.1 Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represents a population, including a sampling point, a process condition, or an environmental condition. Representativeness is the qualitative term that should be evaluated to determine that measurements are made, and physical samples collected, at locations and in a manner resulting in characterizing a matrix or media. Subsequently, representativeness is used to ensure that a sampled population represents the target population and an aliquot represents a sampling unit. This SQAP will be implemented to establish Representativeness for this project. Further, all sampling procedures detailed in the SQAP will be followed to ensure that the data will be representative of the media sampled. The SQAP describes the sample location, sample collection, and handling techniques that will be used to avoid contamination or compromise sample integrity, and ensure proper chain-of-custody of samples. Additionally, the sampling design presented in the SQAP will ensure that there are a sufficient number of samples and level of confidence that analysis of these samples will detect the chemicals of concern, if present.

1.4.2.2 Comparability

Comparability is the qualitative term that expresses the measure of confidence that two data sets or batches can contribute to a common analysis and evaluation. Comparability with respect to laboratory analyses pertains to method type comparison, holding times, stability issues, and aspects of overall analytical quantitation. The following items are evaluated when assessing data comparability:

- Determining if two data sets or batches contain the same set of parameters.
- Determining if the units used for each data set are convertible to a common metric scale.
- Determining if similar analytical procedures and quality assurance were used to collect data for both data sets.
- Determining if the analytical instruments used for both data sets have approximately similar detection levels.
- Determining if samples within data sets were selected and collected in a similar manner.

To ensure comparability of data collected during this investigation to other data that may have been or may be collected for each property, standard collection and measurement techniques will be used.

1.4.2.3 Completeness

Completeness is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples. Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not rejected through data validation. The requirement for completeness is 95% for aqueous samples and 90% for soil and sediment samples.

The following formula is used to calculate completeness:

$$\%\ \text{completeness} = \frac{\text{number of valid results} \times 100}{\text{number of possible results}}$$

For any instances of samples that could not be analyzed for any reason (holding time violations in which resampling and analysis were not possible, samples spilled or broken, etc.), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported.
For this investigation, all samples are considered critical. Therefore standard collection (as defined in the sampling SOPs of Appendix B) and measurement methods will be used to achieve the completeness goal.

1.2.4.4 Precision

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. *Analytical* precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. The laboratory control sample (LCS) determines the precision of the analytical method. If the recoveries of the analytes in the LCS are within established control limits, then precision is within limits. In this case, the comparison is not between a sample and a duplicate sample analyzed in the same batch. Rather, the comparison is between the sample and samples analyzed in previous batches.

Total precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate samples and matrix duplicate spiked samples shall be analyzed to assess field and analytical precision, and the precision measurement is determined using the relative percent difference (RPD) between the duplicate sample results.

The following formula is used to calculate precision:

$$RPD = (100) \times \frac{(S1 - S2)}{(S1 + S2)/2}$$

where:

S1 = original sample value
S2 = duplicate sample value

In general, precision less than or equal to 35% relative percent difference will fulfill the DQOs.

1.4.2.5 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systemic error. It reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike and standard. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS to a control limit. For pesticide, PCB, volatile, and semivolatile organic compounds, system monitoring compound recoveries are also used to assess accuracy and method performance for each sample analyzed. Analysis of performance evaluation (PE) samples may also be used to provide additional information for assessing the accuracy of the analytical data being produced. In general, accuracy between 50% and 150% will fulfill the DQOs.

1.5 Special Training Requirements/Certification

No special training requirements or certifications are required for this project except for the 40-hour Hazardous Waste Operations and Emergency Response class and annual refreshers. Health and safety procedures for E & E personnel are addressed in the E & E site-specific Health and Safety Plan. This document is maintained in E & E's Seattle office. Included in the plan are descriptions of anticipated chemical and physical hazards, required levels of protection, health and safety monitoring requirements and action levels, personal decontamination procedures, and emergency procedures.

1.6 Documentation and Records

This document is meant to be combined with information presented in E & E's (2005b) *Region 10 START-3 Quality Assurance Project Plan*. This information is covered by the SOPs found in Appendix B, the supplemental forms found in Appendix C, and the commercial laboratory quality assurance manual, which has been reviewed previously by E & E. A copy of the START QAPP is available in E & E's Seattle office. Standards contained in the SOPs, the START QAPP, and the QMP will be used to ensure the validity of data generated by E & E for this project.

Following the completion of field work and the receipt of analytical data, a report summarizing project findings will be prepared. Project files, including work plans, reports, analytical data packages, correspondence, chain-of-custody documentation, logbooks, corrective action forms, referenced materials, and photographs, will be provided to the EPA TM at the close of the project. Further, a CD-ROM deliverable containing the final report will be provided.

E & E will assemble and fully document a digital data set including all project sampling, analysis, and observation data. This digital data will be made available in a Microsoft-Access format.

E & E will transfer this data set and documentation to EPA, or if requested, to any other EPA contractor, and shall ensure that any data transferred is received in an uncorrupted, comprehensible, and usable format. Specific data deliverable elements are presented below.

Data

A summary description of the tables, the sources of information and other comments are provided below.

Field-Info

The field information table contains all sample collection related information. A Microsoft Access application (Sample Information System, SIS) will be used to input and store the data. The SIS provides the user with "smart" data input forms that will only allow for the entry of acceptable data field values. For each sampling event, the SIS will be updated to reflect the new samples collected. Once entered, the information will be checked and corrected where necessary. The table structure is presented below.

Field Name	Type	Size	Description
Sample-Num	Character	10	Sample Number
Station	Character	10	Station Identifier
Date	Date	8	Sample Date
Time	Numeric	4	Sample Time (24-Hour clock)
Sampler	Character	25	Person Name
Matrix	Character	6	Sample Matrix – (i.e., soil boring, groundwater, sediment)
Water Depth	Numeric	5.1	Depth of water as sediment sample
Description	Character	40	Sample Description
Comments	Character	40	Comments

Location

The location table contains sample location coordinate information. The sample locations will be determined using Trimble Pro-XR Global Positioning System (GPS) units. E & E personnel have been trained and have utilized these units in similar projects. For each day or half-day in the field that GPS sample location data is to be collected, the GPS user will create a single file that contains the locations of each sample station. A unique station label will be entered for each sample location. This unique station identifier will be used to link the "Location" table with the "Field-Info" table. This information will be downloaded from the GPS unit and imported into the "Location" table of the Site Data Management System (SDMS). All locational data for this project will be stored in decimal degrees, and will be referenced to the North American Datum (NAD) 27 horizontal datum. Differential corrections will be made real-time. The table structure is presented below.

Field Name	Type	Size	Description
Station	Character	10	Station Identifier
X-Coord	Numeric	12.6	X-Coordinate, Decimal Degrees
Y-Coord	Numeric	12.6	Y-Coordinate, Decimal Degrees

Lab Analytical

The Lab Analytical table will hold all of the sample analysis results provided by each laboratory analyzing samples. The integrity of each data file received from the labs will be checked and verified. Once the files are received, they will be appended into the SDMS Lab Analytical table. The "Sample-num" field will be used to link the "Lab Analytical" table with the "Field-Info" table. The table structure is presented below.

Field Name	Type	Size	Description
Sample-num	Character	10	Sample Number
Lab-id	Character	10	Laboratory Sample Identifier
Method	Character	25	Analytical Method Used
L-Matrix	Character	10	Laboratory Matrix
Cas-num	Character	15	Chemical Abstracts
Analyte	Character	40	Analyte Name
Result	Numeric	12.6	Analysis Result
Qual	Character	6	Sample qualifier
Quantitation-Limit	Numeric	12.6	Sample quantitation limit
Units	Character	10	Results unit
Date	Date	8	Date analyzed
Lab	Character	40	Lab name

For any Geographic Information Systems (GIS) produced maps, E & E shall provide the maps to EPA in hard copy and digital image (i.e. JPEG) formats.

Table 1-1 Ground Water Drinking Water Population

Distance Ring (miles)	Well Identification	Well Population	Total Population per Distance Ring
0 - ¼	Domestic – 1	2.92	39.42
	Public Supply – 1	36.5	
¼ - ½	Domestic – 5	14.6	14.6
½ - 1	Domestic – 5	14.6	14.6
1 – 2	Domestic – 60	175.2	211.7
	Public Supply – 1	36.5	
2 – 3	Domestic – 300	876	4,298.23
	Public Supply – 1	3,422.23	
3 – 4	Domestic – 316	922.7	6,134.89
	Public Supply – 1	5,212.19	
TOTAL			**10,713.44**

Sources: DOC 2001; Ecology 2008
Note: Domestic well population was estimated based on the average number per persons per household for Grant County, Washington of 2.92 people.

Table 1-2 Population Within One Mile

Distance Ring	Population	Distance Weighted Population Value
0 to ¼ mile	1	0.1
¼ to ½ mile	3	0.05
½ to 1 mile	32	0.3
Total distance weighted population value		**0.45**

Table 1-3 Population and Wetland Acreage by Distance Ring

Distance (miles)	Population	Wetland Acreage
On a source	35 [a]	0
0 – ¼	1	19.45
¼ – ½	3	31.91
½ – 1	32	45.81
1 – 2	146	222.01
2 – 3	1,056 [b]	192.24
3 – 4	1,211 [b]	40.03
TOTAL	**2,449**	**551.45**

Source: E & E 2004; US Department of Education 2007.

[a] Includes workers.

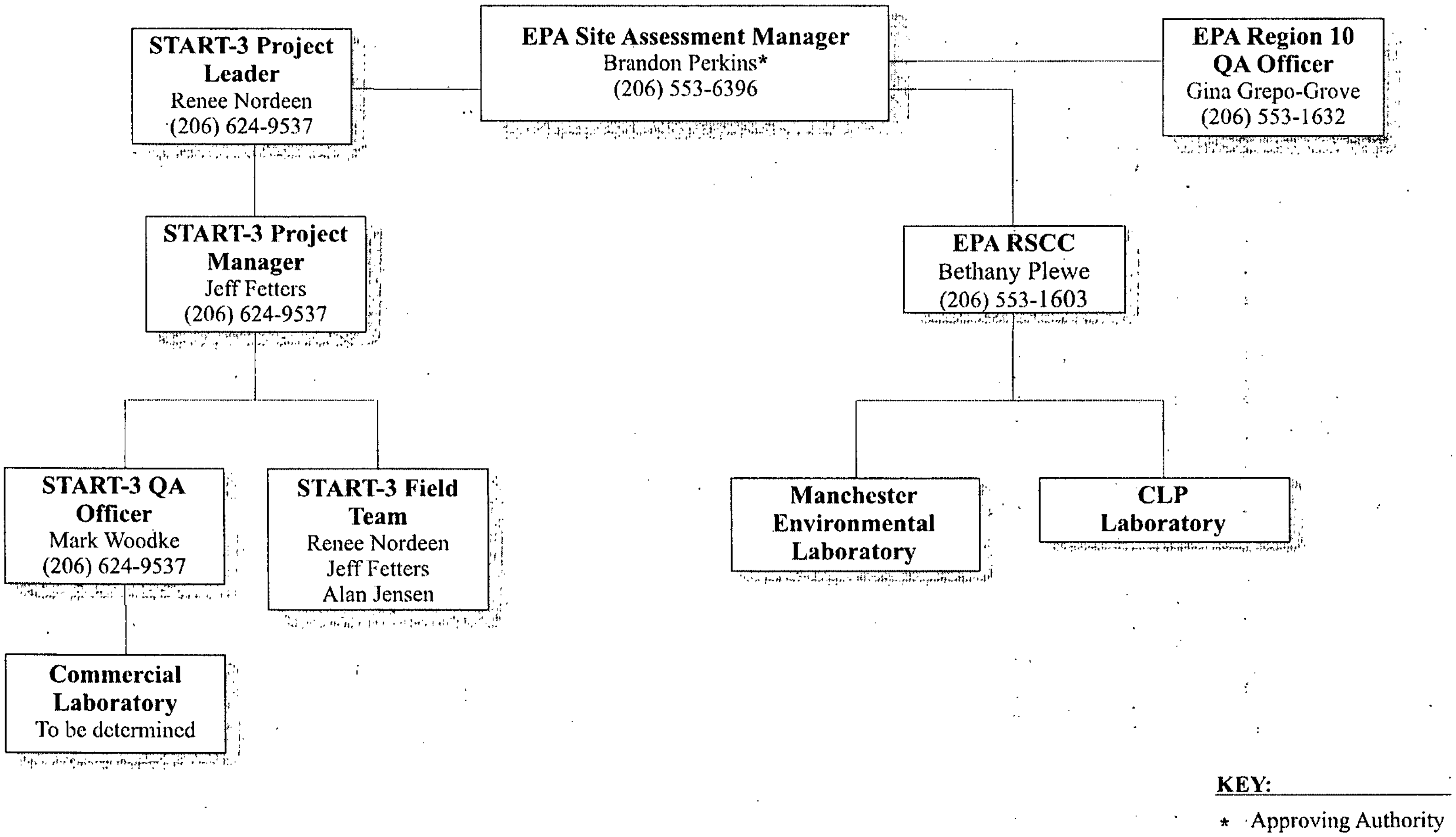
[b] Includes students and teachers at local schools.

Table 1-4 Municipal Water System Well Distribution

Service area	Number of Meters	Total Number of wells	Number of wells within TDL	Meters Services Within TDL	Population Served
Central Zone	2,452	4	1	613	1,789.96
Lakeview Zone	2,344	2	2	2,344	6,844.48
Wheeler Zone	25	2	2	25	73
Total estimated +Population Served					8,707.44

Table 1-5 Proposed Schedule

Activity	Start Date	Completion Date
Collect pertinent background information	May 20, 2008	
Mobilize to the site	September 29, 2008	September 29, 2008
Sample collection activities	September 30, 2008	October 3, 2008
Laboratory receipt of samples	October 1, 2008	October 2, 2008
Demobilization from the site	October 3, 2008	October 3, 2008
Laboratory analysis	October 2, 2008	November 1, 2008
Data validation	October 31, 2008	November 21, 2008
Writing of the project report	October 6, 2008	December 26, 2008
Target project completion date		January 31, 2009

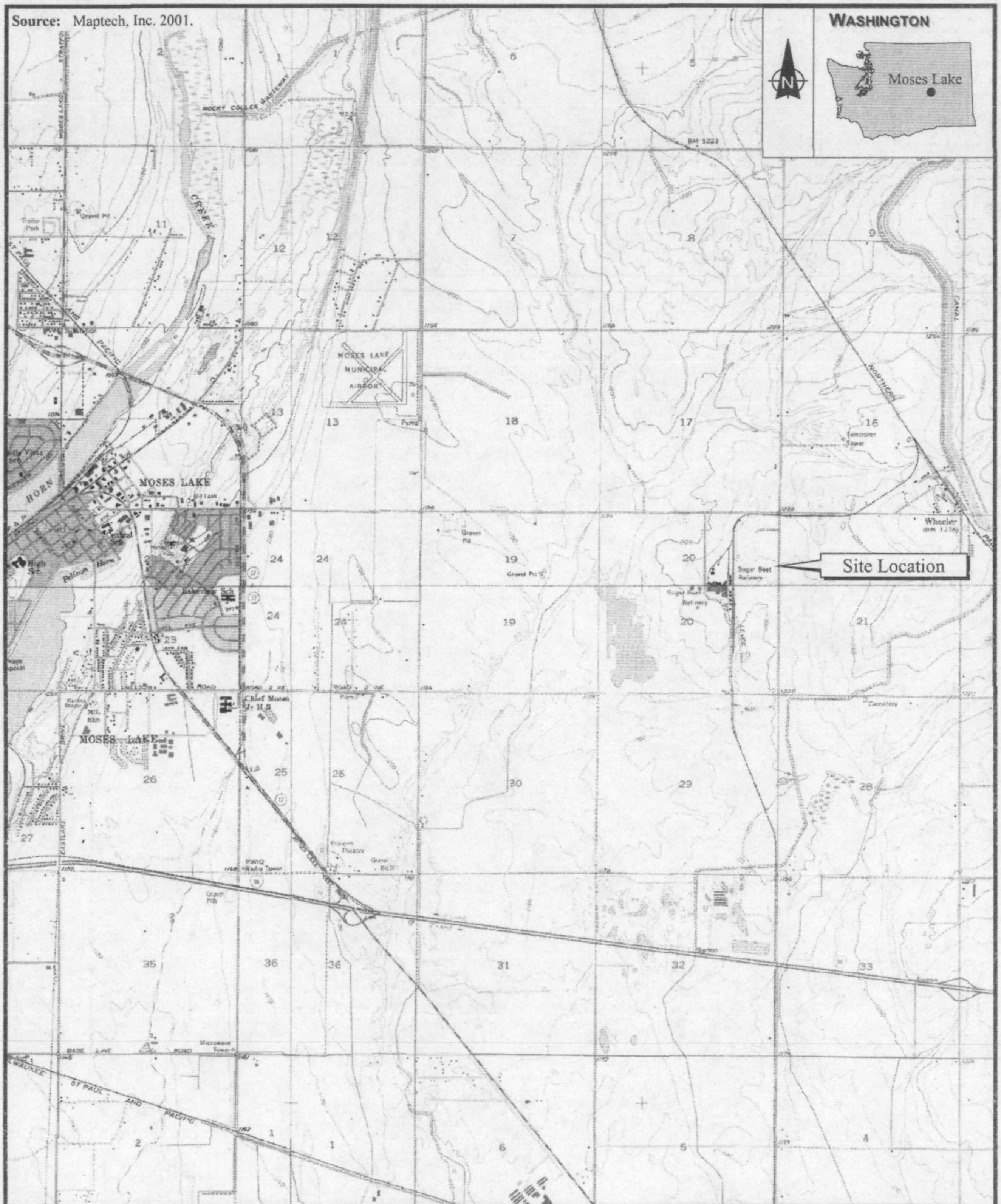


ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

EKA CHEMICALS, INC.
Moses Lake, Washington

Figure 1-1
PROJECT ORGANIZATION CHART

Date:	Drawn by:	
8/20/08	AES	10:START-3\08050005\fig 1-1



ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

EKA CHEMICALS, INC.
Moses Lake, Washington

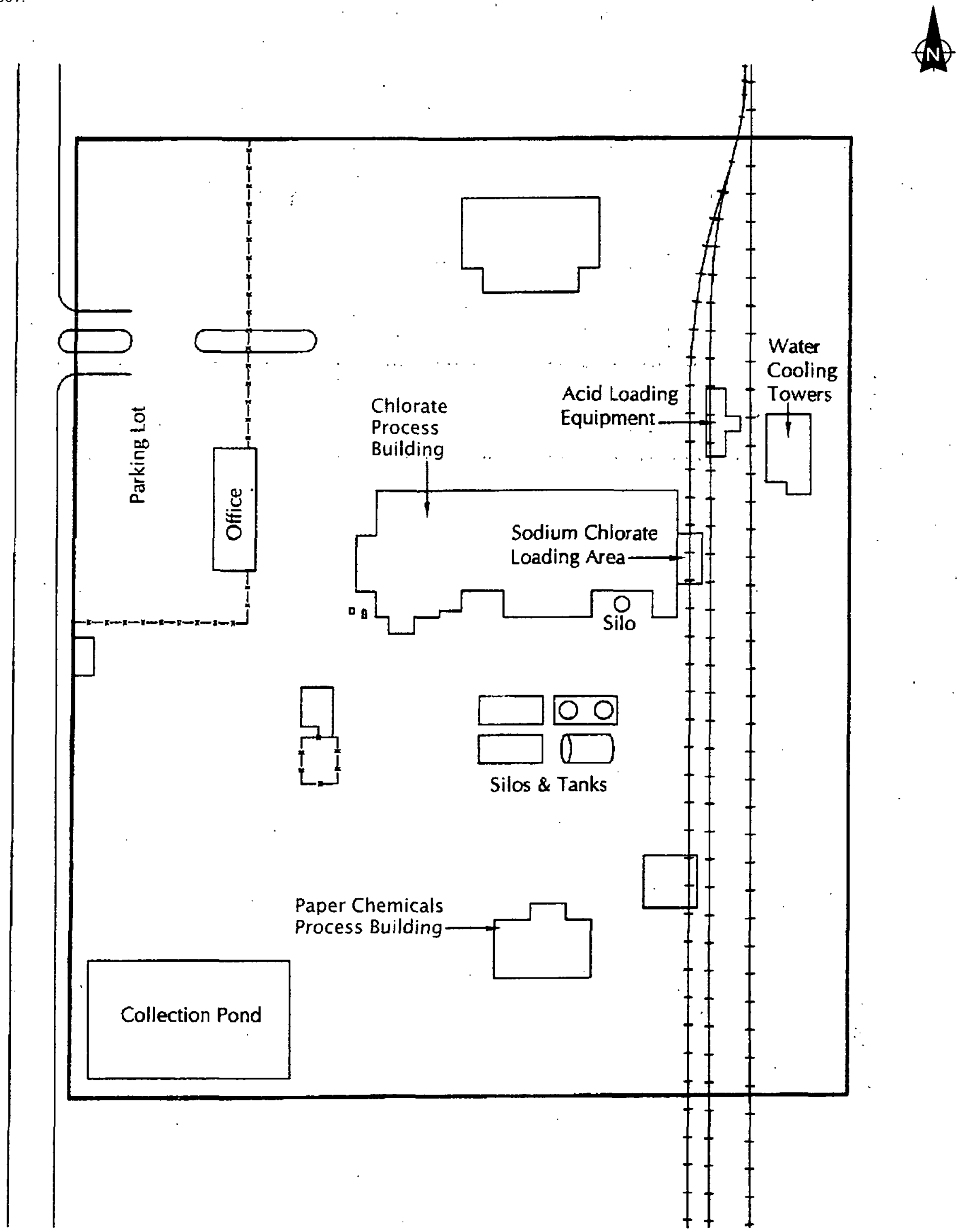
Figure 1-2

SITE LOCATION MAP

0 2000 4000
Approximate Scale in Feet

Date:	Drawn by:	
8-26-08	AES	10:START-3\08050005\fig 1-2

Source: LFR 2007.



ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

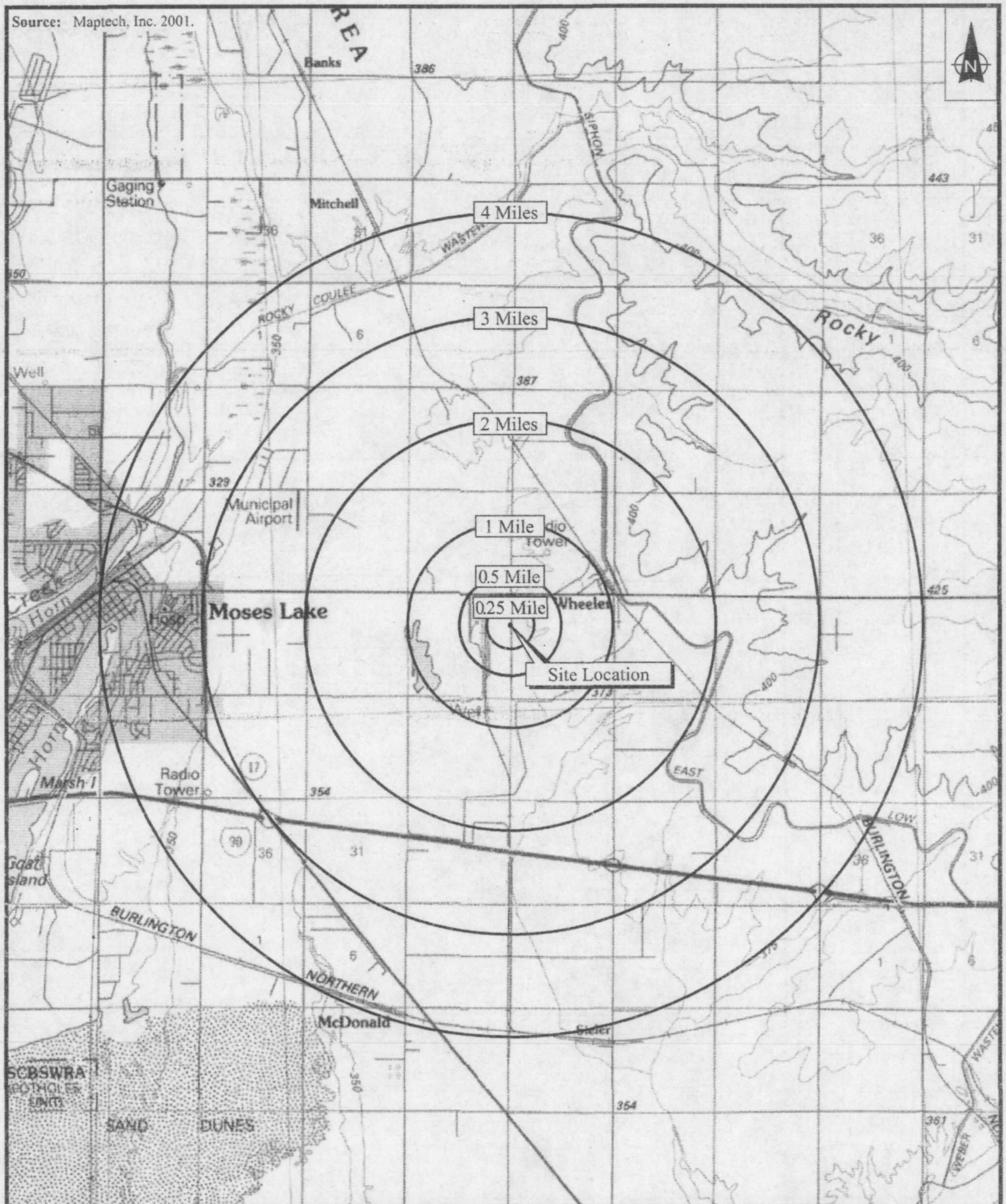
EKA CHEMICALS, INC.
PRELIMINARY ASSESSMENT
Moses Lake, Washington

Figure 1-3

SITE MAP

0 75 150
Approximate Scale in Feet

Date:	Drawn by:	
3-5-08	AES	10:START-3\07120012\fig 1-3



ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

EKA CHEMICALS, INC.
Moses Lake, Washington

0 .5 1
Approximate Scale in Miles

Figure 1-4
4-MILE MAP

Date:	Drawn by:	
8-26-08	AES	10:START-3\08050005\fig 1-4

2

Measurement/Data Acquisition

2.1 Sampling Process Design (Experimental Design)

During the Eka SI, samples will be collected from locations or features considered potential contamination sources, from selected potential hazardous substance migration pathways, and from potential targets in those pathways. The locations or features to be sampled have been determined based on information derived from a review of background information and interviews with site representatives and with regulatory agencies. Table 2-1 provides sample information regarding the sampling design and whether the measurement is considered critical or noncritical.

At the time of sampling, site-specific conditions (e.g., topography or visual evidence of contamination) will be evaluated and incorporated, when applicable, into the placement of sampling locations. Other conditions potentially contributing to deviations from the projected sampling locations include new observations or information obtained in the field that warrant an altered sampling approach, difficulty in reaching a desired soil sampling depth caused by high density soil, obstructions, or limited access to a sampling location. Significant deviations from the planned sampling locations or number of samples to be collected will be discussed with the EPA TM before implementation and will be documented on a Sample Plan Alteration Form (SPAF-Appendix D). Every attempt will be made to collect representative samples with the equipment being used.

This subsection will describe sample locations (subsection 2.1.1), the GPS (subsection 2.1.2), logistics (subsection 2.1.3), cooler return (subsection 2.1.4), and coordination with federal, state, and local authorities (subsection 2.1.5).

2.1.1 Sample Locations

Sample locations will be selected to achieve the objectives discussed in subsection 1.3.1. Samples will be submitted for sodium chlorate (modified EPA Method 300) and perchlorate (EPA SW-846 Method 6860). Table 2-2 presents the potential types of samples, analytical methods, specific requirements for sample container size and type, sample preservation and holding times, and special handling requirements for samples expected to be collected at the site. Table 2-3 summarizes the number of QA/QC samples to be submitted according to the method requirements. Proposed sampling locations are presented in Figure 2-1.

A summary of sampling locations and rationale is provided below:

Potential Sources:

- **Acid Loading Area:** Four boreholes will be advanced and sampled around the acid loading equipment. Boreholes will be advanced to a maximum depth of 20 feet bgs, to bedrock, or groundwater, whichever is encountered first. Samples will be collected in four foot increments. Additionally, groundwater samples will be collected from each borehole in which groundwater is encountered. Samples will be analyzed for sodium chlorate and perchlorate.
- **Sodium Chlorate Loading Area:** Two boreholes will be advanced and sampled near the sodium chlorate loading area. One borehole will be located near previous sample point B-6. The second borehole will be located east of the loading area south of previous sample point B-7. Boreholes will be advanced to a maximum depth of 20 feet bgs, to bedrock, or groundwater, whichever is encountered first. Samples will be collected in four foot increments. Additionally, groundwater samples will be collected from each borehole in which groundwater is encountered. Samples will be analyzed for sodium chlorate and perchlorate.
- **South of Sodium Chlorate Loading Area:** Three boreholes will be advanced south of the sodium chlorate loading area. One borehole will be drilled west of previous sample point B-2 and two will be drilled to the east. Boreholes will be advanced to a maximum depth of 20 feet bgs, to bedrock, or groundwater, whichever is encountered first. Samples will be collected in four foot increments. Additionally, groundwater samples will be collected from each borehole in which groundwater is encountered. Samples will be analyzed for sodium chlorate and perchlorate.
- **South of the Storage Tanks and Silos:** One borehole will be advanced south of previous sample point B-1. The Borehole will be advanced to a maximum depth of 20 feet bgs, to bedrock, or groundwater, whichever is encountered first. Samples will be collected in four foot increments. Additionally, a groundwater sample will be collected from the borehole if groundwater is encountered. Samples will be analyzed for sodium chlorate and perchlorate.
- **North of Paper Chemical Process Building:** Two boreholes will be advanced in this location. Boreholes will be advanced to a maximum depth of 20 feet bgs, to bedrock, or groundwater, whichever is encountered first. Samples will be collected in four foot increments. Additionally, groundwater samples will be collected from each borehole if groundwater is encountered. Samples will be analyzed for sodium chlorate and perchlorate.

Targets Samples:

- **Drinking Water Wells**: Groundwater samples will be collected from two nearby wells. One sample will be collected from the City of Moses Lake municipal well #17, which is located approximately 100 feet south of the Eka property. The other sample will be collected from a nearby (with in 0.25 miles) domestic water supply well (to be determined prior to mobilization in the field). Additionally, groundwater samples will be collected from each of the borehole locations in which groundwater is encountered. Groundwater samples will be analyzed for perchlorate and sodium chlorate.

Background:

- **Background Subsurface Soil:** One background borehole will be advanced upgradient from the spill area, north of the water cooling towers, away from the influence of daily site operations. Background samples will be collected at 4-foot intervals to coincide with regular samples and analyzed for perchlorate and sodium chlorate
- **Background Groundwater**: Samples will be collected from upgradient locations based on the assumed direction of groundwater flow. One back ground groundwater sample will be collected from the background subsurface soil borehole, if groundwater is encountered. An additional background sample will be collected from an up gradient well with similar screen depths as the City of Moses Lake well #17. Background groundwater samples will be analyzed for perchlorate and sodium chlorate.

QA/QC:

- **Rinsate Blanks:** One rinsate blank will be collected from the Geoprobe™ cutting shoe. The sample will be analyzed for sodium chlorate and perchlorate.
- **Investigation Derived Waste (IDW):** One sample from each drum of IDW produced will be sampled for waste characterization and disposal. Samples will be analyzed for sodium chlorate and perchlorate.

2.1.2 Global Positioning System

GPS units with data loggers will be used to identify the location coordinates of every sample collected, as well as to delineate the boundaries of the potential source areas. GPS coordinates will be provided in the final Eka SI report as an appendix. If real-time coördinates cannot be obtained for the site, the START-3 will obtain differential correction data from a local source prior to the start of the survey in order to improve the survey resolution.

2.1.3 Logistics

The Eka site is accessible by paved road. START will travel to the site in government or rented vehicle. All field equipment will be loaded and checked prior to departure to the site to ensure that all equipment will be available during the field event. Property access has been obtained.

Sample aliquots collected for fixed laboratory analysis will be delivered to the EPA Region 10 laboratory or an alternative laboratory as directed by the EPA. All fixed-laboratory samples will be shipped daily or every other day or at the end of the field work by commercial airlines for express delivery. Sample control and shipping are discussed in subsection 2.3.

2.1.4 Cooler Return

For laboratories other than the EPA MEL, E & E will provide completed air bills accompanied by plastic envelopes with adhesive backs and address labels in the chain-of-custody bags taped to the inside of the cooler lids so the laboratory can return the coolers to E & E. The air bills will contain the following notation: "Transportation is for the United States Environmental Protection Agency, and the total actual transportation charges paid to the carrier(s) by the consignor or consignee shall be reimbursed by the Government, pursuant to cost reimbursement contract number EP-S7-06-02." This notation will enable the laboratories to return the sample coolers to E & E's warehouse. The air bills will be marked for second-day economy service and will contain the appropriate TDD number for shipment.

For the EPA MEL or commercial laboratories, an arrangement by E & E for cooler return in this manner is not required.

2.1.5 Coordination with Federal, State, and Local Authorities

The START-3 will keep the EPA TM informed of field event progress and issues that may affect the schedule or outcome of the SI , will discuss problems encountered, will inform the EPA of unusual contacts with the public or the media, and will obtain guidance from the EPA regarding project activities when required. Additionally, the START-3 will notify the EPA RSCC with changes to the sampling schedule for MEL and/or CLP analyses and will provide shipping information on every sample shipment within 24 hours of shipment or before noon on Friday for Saturday delivery. All samples will be shipped to the laboratory within 24/48 hours of sample collection.

Before initiation of the SI field activities, the START-3 will provide notification to list the point(s) of contact for the site; property owners/operators, state representatives, city representatives, county representatives, tribal representatives, local residents, etc.

2.2 Sampling Method Requirements

This subsection describes sampling methodologies (subsection 2.2.1), sampling equipment decontamination (subsection 2.2.2), investigation-derived waste (IDW; subsection 2.2.3), and SOPs (subsection 2.2.4).

2.2.1 Sampling Methodologies

The START-3 PM and EPA TM will be responsible for ensuring that appropriate sample collection procedures are followed and will take appropriate actions to correct the deficiencies. All samples collected will be maintained under chain-of-custody and will be stored and shipped in iced coolers.

- **Subsurface Soil Sampling:** Subsurface soil samples will be collected by a Geoprobe ™ hydraulic direct push sampling system. The samples will be collected in dedicated acetate sleeves. The collected material will be placed in a dedicated stainless steel bowl, thoroughly homogenized and placed into a pre-labeled sample container.

- **Geoprobe ™ Groundwater Sampling:** Groundwater samples will be collected using the Geoprobe ™, dedicated Teflon-lined tubing with a nondedicated check valve, and an inertial pumping technique. Sample will be pumped directly into pre-labeled sample containers and preserved as required upon sample collection completion.
- **Well Sampling:** Groundwater wells samples will be collected in accordance with the groundwater wells sampling SOP presented in Appendix B.
- **Rinsate Blank**: Rinsate blank samples are collected by pouring deionized water through the Geoprobe cutting shoe directly into pre-labeled sample containers and preserved as required immediately after collection.
- **IDW Characterization**: IDW characterization samples will be collected from 55-gallon drums containing IDW. The samples will be collected by directly dipping the sample container in the drum and preserved as required immediately after collection.

2.2.2 Sampling Equipment Decontamination

To the greatest extent possible, disposable and/or dedicated personal protective and sampling equipment will be used to avoid cross-contamination. When required, decontamination will be conducted in a central location, upwind, and away from suspected contaminant sources. The following procedures are to be used for all nondedicated sampling equipment used to collect routine samples undergoing trace organic or inorganic constituent analyses:

1. Clean with tap water and nonphosphate detergent, using a brush if necessary to remove particulate matter and surface films. (Equipment may be steam cleaned [soap and high pressure hot water] as an alternative to brushing. Sampling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. PVC or plastic items should not be steam cleaned.)
2. Rinse thoroughly with tap water.
3. Rinse thoroughly with de-ionized water.
4. Rinse with 10% nitric acid if the sample will be analyzed for trace organics.
5. Rinse thoroughly with de-ionized water that has been treated with activated carbon.
6. Use a solvent rinse (hexane or acetone; pesticide grade) if the sample will be analyzed for organics. Do not solvent rinse PVC or plastic items.
7. Air dry the equipment completely.
8. Rinse again with distilled/de-ionized water.
9. Remove the equipment from the decontamination area and cover with plastic. Equipment stored overnight should be wrapped in aluminum foil and covered with clean, unused plastic.

2.2.3 Investigation-Derived Waste

The START field team members will make every effort to minimize the generation of IDW throughout the field event. Attempts will be made to evaporate wastewater from decontamination operations on-site. Any wastewater that cannot be evaporated will be contained in 55-gallon drums, labeled, and disposed of at an approved facility based on analytical results from matrix samples.

Disposable personal protective clothing and sampling equipment generated during field activities will be rendered unusable by tearing (when appropriate), bagged in opaque plastic garbage bags, contained in lined 55-gallon drums, labeled, and disposed of at an approved facility, based on analytical results from matrix samples.

2.2.4 Standard Operating Procedures

The START will utilize the following SOPs (Appendix B) while performing field activities:

- Borehole Sampling
- Field Activity Logbooks;
- Groundwater Well Sampling;
- Geologic Logging;
- Geoprobe ™ Operations;
- Sample Equipment Decontamination;
- Sample Packaging and Shipping;
- Soil Sampling; and
- Water Level Measurements.

2.3 Sample Handling and Custody Requirements

This subsection describes sample identification and chain-of-custody procedures that will be used for the Eka SI field activities. The purpose of these procedures is to ensure that the quality of the samples is maintained during collection, transportation, storage, and analysis. All chain-of-custody requirements comply with E & E's SOPs for sample handling. All sample control and chain-of-custody procedures will follow the EPA's (2004b) *Contract Laboratory Program Guidance for Field Samplers*.

Examples of sample documents used for custody purposes are provided in Appendix C (with the exception of field logbooks) and include the following:

- Sample identification numbers,
- Sample tags or labels,
- Custody seals,
- Chain-of-custody records or traffic reports,
- Field logbooks,
- Sample Collection Forms, and
- Analytical request forms.

During the field effort, the site manager or delegate is responsible for maintaining an inventory of these sample documents. This inventory will be recorded in a cross-referenced matrix of the following:

- Sample location,
- Sample identification number,
- Analyses requested and request form numbers,
- Chain-of-custody record numbers,
- Bottle lot numbers, and
- Air bill numbers.

Brief descriptions of the major sample identification and documentation records and forms are provided below.

2.3.1 Sample Identification

All samples will be identified using the sample numbers assigned by the EPA RSCC. Each sample label will be affixed to the jar and covered with clear tape. A sample tracking record will be kept as each sample is collected. The following will be recorded: location, matrix, sample number, observations, and depth. In addition to the EPA-assigned sample number, samples will be tracked with a sample code system designed to allow easy reference to the sample's origin and type. The sample code key will not be provided to the laboratory. Table 2-4 summarizes the sample tracking and location codes.

2.3.1.1 Sample Tags and Labels

Sample tags attached to or fixed around sample containers will be used to identify all samples collected in the field. The sample tags will be placed on bottles so as not to obscure any QA/QC lot numbers on the bottles, and sample information will be printed legibly. Field identification will be sufficient to enable the information to be cross-referenced with the project logbook. For chain-of-custody purposes, all QA/QC samples will be subject to the same custodial procedures and documentation as site samples.

To minimize handling of sample containers, labels will be completed before sample collection to the extent possible. In the field, the labels will be filled out completely using waterproof ink, then attached firmly to the sample containers and protected with clear tape. The sample labels will provide the following information:

- Sample number,
- Sample location number,
- Date and time of collection,
- Analyses required, and
- pH and preservation (when required).

2.3.1.2 Custody Seals

Custody seals are preprinted gel-type seals, designed to break into small pieces if the seals are disturbed. Sample shipping containers (e.g., coolers, drums, cardboard boxes, etc., as appropriate) will be sealed in as many places as necessary to ensure security. Seals will be signed and dated before use. Clear tape will be placed over the seals to ensure that the seals are not broken accidentally during shipment. Upon receipt at the laboratory, the custodian will check (and certify by completing the package receipt log) that seals on shipping containers are intact.

2.3.1.3 Chain-of-Custody Records and Traffic Reports

For samples to be analyzed at the EPA MEL or at a CLP laboratory, the chain-of-custody records, analyses required forms, and/or analytical traffic report forms will be completed as described in the *Contract Laboratory Program Guidance for Field Samplers* (EPA 2004b). The EPA's FORMS II Lite software will be used to electronically enter information for the chain-of-custody and traffic report forms. The chain-of-custody record, analyses required forms, and analytical traffic reports will be completed fully at least in duplicate by the field technician designated by the site manager as responsible for sample shipment to the appropriate laboratory. Information specified on the chain-of-custody record will contain the same level of detail found in the site logbook, except that the on-site measurement data will not be recorded. The custody record will include the following information:

- Name and company or organization of person collecting the samples,
- Date samples were collected,
- Type of sampling conducted (composite or grab),
- Sample number (using those assigned by the EPA RSCC),
- Location of sampling station (using the sample code system described in Table 2-4),
- Number and type of containers shipped,
- Analysis requested, and
- Signature of the person relinquishing samples to the transporter, with the date and time of transfer noted and signature of the designated sample custodian at the receiving facility.

If samples require rapid laboratory turnaround, the person completing the chain-of-custody record(s) will note these or similar constraints in the remarks section of the custody record.

The relinquishing individual will record all shipping data (e.g., air bill number, organization, time, and date) on the original custody record, which will be transported with the samples to the laboratory and retained in the laboratory's file. Original and duplicate custody records, together with the air bill(s) or delivery note(s), constitute a complete custody record. It is the site manager's responsibility to ensure that all records are consistent and that they become part of the permanent job file.

2.3.1.4 Field Logbooks and Data Forms

Field logbooks (or daily logs) and data forms are necessary to document daily activities and observations. Documentation will be sufficient to enable participants to reconstruct events that occurred during the project accurately and objectively at a later time. All daily logs will be kept in a bound notebook containing numbered pages. All entries will be made in waterproof ink, dated, and signed. No pages will be removed for any reason.

Minimum logbook content requirements are described in the E & E SOP entitled *Field Activity Logbooks* found in Appendix B. If corrections are necessary, these corrections will be made by drawing a single line through the original entry (so that the original entry is legible) and writing the corrected entry alongside. The correction will be initialed and dated. Corrected errors may require a footnote explaining the correction.

2.3.1.5 Photographs

Photographs will be taken as directed by the team leader. Documentation of a photograph is crucial to its validity as a representation of an existing situation. The following information will be noted in the project or task log concerning photographs:

- Date, time, and location where photograph was taken,
- Photographer (signature),
- Weather conditions,
- Description of photograph taken,
- Reasons why photograph was taken,
- Sequential number of the photograph and the film roll number,
- Camera lens system used, and
- Direction.

2.3.2 Custody Procedures

The primary objective of chain-of-custody procedures is to provide an accurate written or computerized record that can be used to trace the possession and handling of a sample from collection to completion of all required analyses. A sample is in custody when it is:

- In someone's physical possession,
- In someone's view,
- Locked up, or
- Kept in a secured area that is restricted to authorized personnel.

2.3.2.1 Field Custody Procedures

The following guidance will be used to ensure proper control of samples while in the field:

- As few people as possible will handle samples.
- Coolers or boxes containing cleaned bottles will be sealed with a custody tape seal during transport to the field or while in storage before use. Sample bottles from unsealed coolers or boxes, or bottles that appear to have been tampered with, will not be used.
- The sample collector will be responsible for the care and custody of collected samples until they are transferred to another person or dispatched properly under chain of custody rules.

- The sample collector will record sample data in the field logbook.
- The site team leader will determine whether proper custody procedures were followed during the field work and will decide if additional samples are required.

When transferring custody (i.e., releasing samples to a shipping agent), the following will apply:

- The coolers in which the samples are packed will be sealed and accompanied by two copies of the chain of custody record(s). When transferring samples, the individuals relinquishing and receiving them must sign, date, and note the time on each of the chain of custody record(s). This will document sample custody transfer.
- Samples will be dispatched to the laboratory for analysis with separate chain of custody records accompanying each shipment. The chain of custody records will be signed by the relinquishing individual, and the method of shipment, name of courier, and other pertinent information will be entered in the chain of custody record before placement in the shipping container. Shipping containers will be sealed with custody seals for shipment to the laboratory.
- All shipments will be accompanied by chain of custody records identifying their contents. The original custody records kept in a zip-locking bag and taped inside the lid of the cooler will accompany each cooler shipment. The other copies will be distributed appropriately to the site team leader and site manager.
- If sent by common carrier, a bill of lading will be used. Freight bills and bills of lading will be retained as part of the permanent documentation.

2.3.2.2 Laboratory Custody Procedures

A designated sample custodian at the laboratory will accept custody of the shipped samples from the carrier and enter preliminary information about the package into a package or sample receipt log, including the initials of the person delivering the package and the status of the custody seals on the coolers (i.e., broken versus unbroken). The custodian responsible for sample log-in will follow the laboratory's SOP for opening the package, checking the contents, and verifying that the information on the chain-of-custody agrees with the samples received. The commercial laboratory will follow its internal chain-of-custody procedures as stated in the laboratory QA manual. The laboratory will check the temperature blank inside the cooler and document it in the sample log-in form. Should the temperature be greater than what is required by the Statement of Work or the method, the sample custodian will inform the region and proceed to follow the course of actions stipulated in the SOW or specified by the regional QAO.

2.4 Analytical Methods Requirements

This subsection discusses the analytical strategy (subsection 2.4.1) and the analytical methods (subsection 2.4.2).

2.4.1 Analytical Strategy

Analysis of samples collected during the SI will be performed by several possible means. The MEL (or alternative laboratory designated by the EPA) will perform all requested.

The analyses to be applied to samples sent to the laboratory are listed in Table 2-2. These analyses were selected based on the probable hazardous substances used or potentially released to the environment, given the known or suspected site usage.

2.4.2 Analytical Methods

Samples designated for off-site analytical laboratory analyses will be submitted to the MEL or an alternative laboratory designated by the EPA and the START-3-subcontracted commercial laboratory. EPA and/or CLP laboratory analyses will take place within the standard three-week turnaround time period, with validation by the EPA QA office for these analyses taking place within the standard three-week turnaround time period. Hardcopy results from the MEL and/or CLP laboratories will be delivered to the EPA upon completion of each sample delivery group. Electronic results from the MEL and/or CLP laboratories will be delivered to the EPA upon project completion. START-3 sub-contracted laboratory analyses will take place within the standard four-week turnaround time period with validation by START-3 chemists for these analyses taking place within the standard two-week turnaround time period. Hardcopy and electronic data results from the subcontracted commercial laboratory will be delivered to the START-3 upon completion of each sample delivery group. Table 2-2 summarizes laboratory instrumentation and methods to be used for the Eka SI.

For cases in which laboratory results exceed QC acceptance criteria, reextraction and/or reanalysis will occur as indicated in the applicable analytical method. Commercial laboratory results (preliminary data) will be available within two weeks of sample receipt. Field laboratory results will be available within 24 hours. The respective laboratory analysts will be responsible for ensuring that appropriate sample analysis procedures are followed and for taking appropriate actions to ensure deficiency correction

2.5 Quality Control Requirements

QC checks for sample collection will be accomplished by a combination of chain-of-custody protocols and laboratory QA procedures as prescribed in the sampling or analytical methods. No QC samples (i.e., double blind performance evaluation samples) are planned for this activity outside of the normal laboratory QC criteria outlined in the analytical methods. These QC samples include blanks, calibration verifications, spikes, duplicates, (for inorganics) interference check samples, and serial dilutions. Results from these samples will be compared to QC requirements listed in subsection 4.1.2. All of the analyses that will be performed for this project will produce definitive data. Data quality indicator targets for this project are specified in subsection 1.4 (Data Quality Objectives) and are summarized in Table 2-2 of this SQAP. Bias on estimated qualified data shall be determined by the validation process. In accordance with the objectives outlined in this document and the QA levels defined by the EPA (1993), the EPA has defined the DQOs and has determined that the sampling and analyses performed under this sampling effort will conform to the definitive data without quantitative error and bias determination criteria. The laboratories' DQOs for completeness and the field team's ability to meet the DQO for representativeness are set at 90%. Precision and accuracy requirements are outlined in Table 2-3.

One temperature blank consisting of a 40-milliliter glass vial of distilled water will be included in each cooler shipped to the analytical laboratories. Temperature blanks allow the laboratories to obtain a representative measurement of the temperature of samples enclosed in a cooler without disturbing the actual samples. The field team will package and label the temperature blank like a regular water sample, however the analytical laboratory will only measure the temperature of the blank. The temperature blank will not be analyzed for hazardous substances, will not be given a sample number, and will not be listed on the chain of custody form. The temperature blank will be clearly labeled: USEPA COOLER TEMPERATURE INDICATOR.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

The field equipment used during this project includes the GPS unit and an organic vapor analyzer/flame ionization detector. Testing, inspection, and maintenance of these instruments will be performed in accordance with the manufacturers' recommendations and/or the SOPs listed in subsection 2.2.4. Spare parts for the field equipment will be available from the manufacturer generally within 24 hours. The parts will be available to the field team within 48 hours of ordering.

All field instruments and equipment used for analysis will be serviced and maintained only by qualified personnel. All instruments will be maintained by senior staff and/or electronics technicians. All repairs, adjustments, and calibrations will be documented in an appropriate logbook or on a data sheet that will be kept on file. The instrument maintenance logbooks will clearly document the date, the description of the problems, the corrective action taken, the result, and who performed the work.

All equipment used by E & E in the field is subject to standard preventive maintenance schedules established by corporate equipment protocols. When in use, equipment will be inspected at least twice daily, once before startup in the morning and again at the end of the work shift before overnight storage or return to the charging rack. Regular maintenance, such as cleaning of lenses, replacement of in-line filters, and removal of accumulated dust, is to be conducted according to manufacturers' recommendations and in the field as needed, whichever is appropriate. All performed preventive maintenance will be entered in the individual equipment's logbook and in the site field logbook.

In addition to preventive maintenance procedures, daily calibration checks will be performed at least once daily before use and recorded in the respective logbooks. Additional calibration checks will be performed as required. All logbooks will become part of either the permanent site file or the permanent equipment file.

2.7 Instrument Calibration and Frequency

All instruments and equipment used during fixed laboratory sample analyses will be operated, calibrated, and maintained according to the manufacturers' guidelines and recommendations, as well as criteria set forth in the applicable analytical methodology references and/or in accordance with the laboratory's QA manual and SOPs.

For the field instrumentation (GPS unit and other instrumentation discussed previously), calibrations will be performed in accordance with the manufacturers' recommendations and the SOPs listed in subsection 2.2.4.

2.8 Inspection/Acceptance Requirements for Supplies and Consumables

This information is covered by the SOPs, the START-3 QAPP (E & E 2005b), and the START-3 QMP (E & E 2005a). Standards contained in these documents will be used to ensure the validity of data generated by E & E for this project. Sample jars are precleaned by the manufacturer; certification documenting this is enclosed with each box of jars. The START-3 will include this documentation as part of the site file. Nondedicated equipment is demonstrated to be uncontaminated by the use of rinsate blanks.

2.9 Data Acquisition Requirements (Nondirect Measures)

No data will be used from other sources.

2.10 Data Management

This document is meant to be combined with information presented in E & E's QAPP and QMP for Region 10 START-3. Copies of the START QAPP and QMP are available in E & E's Seattle office. Standards contained in these documents will be used to ensure the validity of data generated by E & E for this project. Data validation will be performed as listed in subsection 4.1.2. Data tracking, storage, and retrieval are tracked through the TDD Ablue sheet,@ which records where the paper and electronic data are located. All paper data is stored in locked file cabinets; access to these files is restricted to key START-3 personnel. Electronic data will be archived by TDD.

Table 2-1 Sample Collection Summary

Project Sampling Schedule[a]	Parameters/ Limits	Design Rationale	Sampling Design Assumptions	Sample Selection Procedures	Measurements Classification (Critical/ Noncritical)	Nonstandard Method Validation
Soil Samples	Perchlorate and Sodium Chlorate	Determine if contaminants are present.	Contaminants were historically released to the soil.	Samples will be collected from potentially contaminated areas.[b]	Critical	NA
Groundwater Samples	Perchlorate and Sodium Chlorate	Determine if contaminants are present.	Contaminants are migrating from the site to groundwater.	Samples will be collected from potentially contaminated areas.[b]	Critical	NA

Notes:
[a] All samples will be collected during the field event.
[b] As indicated from previous site visits and from on-site observations.

Key:

Critical = Required to achieve project objectives or limits on decision errors
NA = Not Applicable
Noncritical Not required to achieve project objectives

Table 2-2 Sample Analysis Summary

Matrix	Quantity[a]	Analytical Parameters/ Method	Sample Preservation	Technical Holding Time[b]	Sample Container(s)
Soil	Up to 65 samples	Perchlorate (EPA SW-846 Method 6860) Sodium Chlorate (Modified EPA Method 300.0)	Cool to 4°C ± 2°C	28 days from collection to extraction & 28 days from extraction to analysis	One 8-ounce amber glass jar
Water	up to 15 samples	Perchlorate (EPA SW-846 Method 6860) Sodium Chlorate (Modified EPA Method 300.0)	Cool to 4°C ± 2°C	28 days from collection to analysis	Two 500-ml polyethylene bottles (the perchlorate sample must be filtered during collection with a 0.2 um PTFE membrane filter)

Notes:

[a] The number of samples presented is an estimate; the actual number of samples to be collected will be determined in the field.

[b] Technical holding times have been established only for water matrices. Water technical holding times were applied to sediment, soil, and product samples when applicable; in some cases, recommended sediment/soil holding times are listed.

Table 2-3 QA/QC Analytical Summary and Fixed Laboratory Analytical Methods

Laboratory	Matrix	Parameters/ Method	Method Description/ Detection Limits	Total Field Samples[a]/ Containers	QA/QC Sample Summary: Organic MS/MSD[b]	Field Duplicate	Lab Duplicate	Rinsate Blank	Trip Blanks	Total Field and QA/QC Analyses/ Containers	Precision and Accuracy[e]
EPA Region 10 or Commercial Laboratory	Soil	Perchlorate (EPA SW-846 Method 6860) Sodium Chlorate (Modified EPA Method 300.0)	IC/ESI/MD / 0.1 mg/kg IC / 1 mg/kg	65/65	4 / 0	0	0/0	NA	NA	69/65	35% / 65% - 135%
	Water	Perchlorate (EPA SW-846 Method 6860) Sodium Chlorate (Modified EPA Method 300.0)	IC/ESI/MD / 0.05 µg/L IC / 1 µg/L	15/15	1 / 2	0	0/0	NA	NA	3/4	30% / 70% - 130%

Notes:

a Total number of field samples is estimated.

b No extra volume is required for soil/sediment or product samples; for water samples, triple volume is required for organic analyses, and double volume is required for inorganic analyses. Sample numbers are based on 1 matrix spike/matrix spike duplicate (MS/MSD) per 20 samples per matrix.

c The total number of rinsate samples could vary depending on the total number of samples collected. The sample numbers are based on one rinsate per 20 samples per nondedicated sampling device. Note that rinsate blanks consist of water aliquots for both soil and water field samples.

d The total number of trip blanks could vary depending on the total number of sample shipments. This number is based on the estimated number of shipping containers. Note that trip blanks consist of water aliquots for both soil and water field samples.

e Total analyses and containers includes both field and QA/QC aliquots to be submitted for fixed laboratory analysis. Note that trip blanks and rinsate blanks consist of water aliquots for both soil and water field samples.

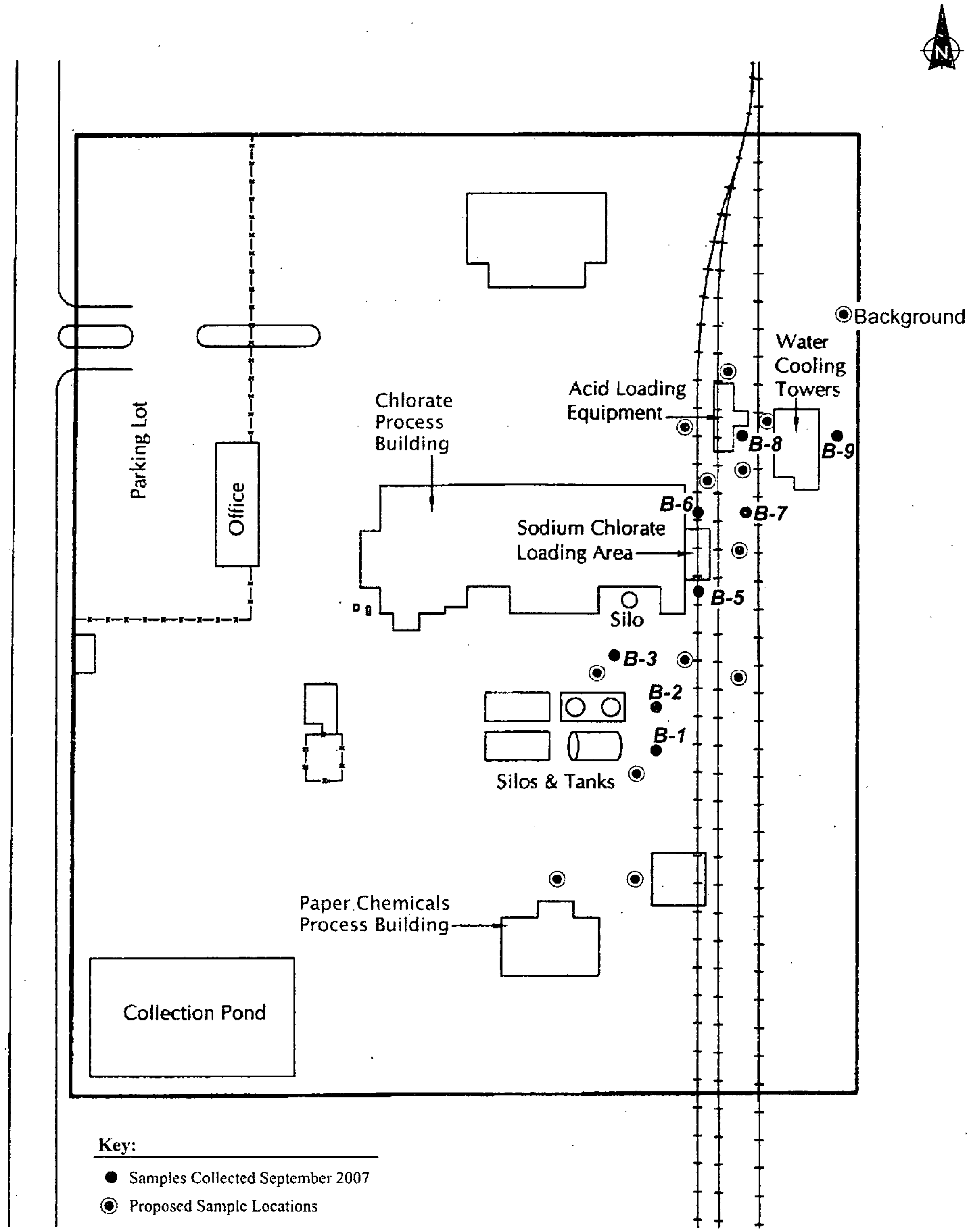
Key:

EPA	= Environmental Protection Agency.	MD	= Mass spectrometric detection.	NDMA	= N-nitrosodimethylamine.
ESI	= Electrospray Ionization.	MS/MSD	= Matrix spike/matrix spike duplicate.	QA	= Quality assurance
GCS	= Gas chromatographic separation.	µg/L	= micrograms per liter.	QC	= Quality control.
IC	= Ion chromatography.	NA	= Not applicable.		

Table 2-4 Sample Coding

Digits	Description	Code	Example
1,2	Area	AL	Acid Loading Area
		BK	Background
		PC	North of Paper Chemical Processing Building
		CL	Sodium Chlorate Loading Area
		SC	South of Sodium Chlorate Loading Area
		SS	South of Storage Tanks and Silos
3,4	Consecutive Number	01	First Sample of Source Type
5,6	Matrix Code	GW	Groundwater
		RS	Rinsate
		SB	Subsurface Soil
7,8	Consecutive Number	01	Lowest depth of subsurface soil sample

Source: LFR 2007.



Note: Sample locations are approximate.

ecology and environment, inc. International Specialists in the Environment Seattle, Washington	EKA CHEMICALS, INC. Moses Lake, Washington	Figure 2-1 SITE MAP		
	0 75 150 Approximate Scale in Feet	Date: 7-8-08	Drawn by: AES	10:START-3\08050005\fig 2

3 Assessment/Oversight

3.1 Assessment and Response Actions

The EPA QAO or designee may conduct an audit of the field activities for this project. The auditor will have the authority to issue a stop work order upon finding a significant condition that adversely would affect the quality and usability of the data. The EPA TM will have the responsibility for initiating and implementing response actions associated with findings identified during the site audit. The actions taken also may involve the EPA PO, contracting officer, and/or QAO. Once the response actions have been implemented, the EPA QAO or designee may perform a follow-up audit to verify and document that the response actions were implemented effectively. In-house audits performed by the START-3 may be conducted in accordance with the E & E START-3 *Quality Management Plan* (2005a). No audits are planned for the Eka SI.

If major deviations from the QA requirements of the project and the CLP SOW were observed in the data validation process, the EPA QAO will contact the laboratory to correct the problem. If the laboratory is not responsive to the request, the QAO will inform the CLP Regional PO and the TM of the situation. A brief narrative will be written explaining the contract deviations and recommendations will be given based on the quality of the submitted data. Reduced payment and/or reanalysis at the laboratory's expense shall be pursued by the Regional CLP PO. Resampling and subsequent re-analysis will be decided by the TM. Additional sampling for corrective actions and/or any addendum to this SQAP shall be documented using the Corrective Action Form and the SPAF (Appendix D). Corrective actions will be conducted in accordance with E & E QMP specifications.

3.2 Reports to Management

Debriefing of the EPA TM occurs by the START-3 PM on a daily basis. Laboratory deliverables will be as specified in the CLP Organic Statement of Work (SOM01.2) for CLP data, CLP-equivalent deliverables for MEL data, and as specified in the laboratory subcontract bid specification package for commercial laboratory data. Once the project is complete and the resulting data is obtained, the START-3 PM will prepare a final project report. The report will include a summary of the activities performed during the project and the resulting data (along with any statements concerning data quality). The report will be approved by the EPA TM prior to being forwarded to the individuals identified in the data distribution list located in the Table of Contents section of this SQAP.

The START-3 corrective action program is addressed in Section 3 of the QMP. Corrective actions will be conducted in accordance with these QMP specifications.

4 Data Validation and Usability

4.1 Data Review, Validation, and Verification Requirements

The data validation review of data packages will include an evaluation of the information provided on the analytical data sheets and required support documentation for all sample analyses; the supporting sample collection documentation, including chain-of-custody forms; and documentation of field instrument calibration, sample results, and/or performance checks (if required by the method). The QA review also will examine adherence to the procedures as described in the cited SOPs and the specified analytical methods in the SQAP.

4.1.1 Data Reduction

Data reduction includes all processes that change the numerical value of the raw data. All fixed-laboratory data reduction will be performed in accordance with the appropriate methodology and will be presented as sample results.

4.1.2 Data Validation

Analytical data generated through the CLP contract will be validated in a three week turn around time by the Region 10 QA office or its designee. Data generated by the MEL will be validated by the EPA TM designated validator (i.e., EPA QA office or contractor). Validation of data generated by subcontracted laboratories will be performed by E & E. All of the data validations will be performed in accordance with the QA/QC requirements specified in the SQAP, the technical specifications of the analytical methods, and the following documents:

- USEPA *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (EPA 2008).

The QC parameters of interest for the EPA organic methods that will be used on the Eka SI samples are presented in these documents. When applicable, QC criteria listed in the applicable analytical methods and/or the SOW will be used for validation.

Validation deliverables will include a QA memo discussing QA conformance and deviations issues which may have affected the quality of the data. Data usability, bases of application of qualifiers, and percentage of qualified data will also be discussed in the QA memo. The analysis data sheets (Forms I) with the applied validation qualifiers and bias determination for estimated-qualified values will also be a part of the validation deliverables. The following qualifiers shall be used in data validation:

- U = The material was analyzed for but was not detected. The associated numerical value is the sample quantitation limit.
- J = The associated numerical value is an estimated quantity because the reported concentrations were less than the sample quantitation limits or because quality control criteria limits were not met.
- UJ = The material was analyzed for, but not detected. The reported detection limit is estimated because Quality Control criteria were not met.
- R = The sample results are rejected (analyte may or may not be present) due to gross deficiencies in quality control criteria. Any reported value is unusable. Resampling and/or reanalysis is necessary for verification.
- H = High bias.
- K = Unknown bias.
- L = Low bias.
- Q = Detected concentration is below the method reporting limit/Contract Required Quantitation Limit, but is above the method quantitation limit.

4.1.3 Data Assessment Procedures

Following data validation and reporting, all project-generated and -compiled data and information will be reconciled with the objectives specified in subsection 1.3.1 to assess the overall success of SI activities. This data assessment, including points of achievement and departure from project-specific objectives, will be discussed in the QA section of the SI report.

4.2 Data Verification

The analytical QA requirements and data validation requirements will be as specified in subsection 4.1.2 (EPA 2008).

The EPA TM will perform the final review and approval of the data. The EPA TM and/or QAO will look at matrix spike/matrix spike duplicates, laboratory blanks, and laboratory duplicates to ensure that they are acceptable. The EPA TM and/or designee also will compare the sample descriptions with the field sheets for consistency and will ensure that any anomalies in the data are documented appropriately.

Data QA memoranda reports will be generated as part of the Eka SI if the START-3 is responsible for data validation. If the EPA Region 10 QA office or its designee performs the data validation, then additional reports regarding data usability will be generated by the START-3.

4.3 Reconciliation with Data Quality Objectives

The data quality indicators target for this project is discussed in subsection 1.4 of this SQAP. The data validation will be used as a tool to determine if these targets were met. Also, using the compiled data, E & E and the TM will determine the variability and soundness of the data and the data gaps that will need to be filled to meet the objectives of the project.

Once the data results are compiled, the EPA TM and/or the EPA QAO will review the sample results to determine if they fall within the acceptance limits as defined in this SQAP. Completeness also will be evaluated to determine if the completeness goal for this project has been met. If data quality indicators do not meet the project's requirements as outlined in this SQAP, the data may be discarded and resampling and reanalysis may occur. The TM will attempt to determine the cause of the failure (if possible) and make the decision to discard the data and resample. If the failure is tied to the analysis, calibration and maintenance techniques will be reassessed as identified by the appropriate laboratory personnel. If the failure is associated with the sample collection and resampling is required, the collection techniques will be reevaluated as identified by the START-3 PM.

5 References

Bain, R.C. Jr., March, 1990, Moses Lake Clean Lake Project, Irrigation Water Management, Final Report.

Bauer, H.H., and Hansen, A.J. Jr., 2000, Hydrology of the Columbia Plateau Regional Aquifer System, Washington, Oregon, and Idaho, U.S. Geological Survey Water-Resources Investigation Report 96-4106.

Bingham, Lind, SH&E/Quality Manager, Eka Chemicals, Inc., February 14, 2008, personal conversation with Mark Woodke, E & E project manager.

Ecology and Environment, Inc. (E & E), February 14, 2008, site visit by Mark Woodke, E & E project manager.

Federal Emergency Management Agency (FEMA), September 30, 1988, Flood Insurance Rate Map, Grant County, Washington.

Hanson, Al, March 20, 2008, Population Calculations, Ecology and Environment, Inc., Seattle, Washington.

LFR, Inc. (LFR), November 1, 2007, *Modified Phase II Environmental Site Assessment*, prepared for Eka Chemicals, Inc., Moses Lake, WA.

Jordan, Jimmy, Manager SH&E, Eka Chemicals, Inc., February 14, 2008, personal conversation with Mark Woodke, E & E project manager.

Maddox, Bill, December 19, 2007, City of Moses Lake Water Division Manager, with Renee Nordeen, Ecology and Environment, Inc.

National Center for Education Statistics (NCES), retrieved December 18, 2007, http://nces.ed.gov/ccc/schoolsearch/school_list.asp?Search=1&DistrictID=5305220.

United States Department of Agriculture (USDA), January 1984, Soil Conservation Service, *Soil Survey of Grant County, Washington*.

United States Department of Commerce (DOC), May 2001, United States Census Bureau, 2000 Profiles of General Demographic Characteristics, Grant County, Washington.

United States Fish and Wildlife Service (USFWS), 2003,.

Washington Department of Ecology (Ecology), retrieved February 4, 2008, http://www.ecy.wa.gov/programs/wq/permits/permit_pdfs/eka_chemicals/Eka%20Chemicals%20ST%208078%20Fact%20Sheet%20-%20Final.pdf

__________, January 4, 2007, *Draft State Waste Discharge Permit No. 8078*.

__________, February 2003, Moses Lake Total Maximum daily Load Groundwater Study, publication #03-03-005

__________, March 1989, *Model Toxics Control Act*, Chapter173-340, Washington Administrative Code.

Washington Department of Health (WDOH), retrieved December 18, 2007, Division of Environmental Health, Office of Drinking Water, Multiple Water System view., City of Moses Lake, Washington.

Washington Department of Fish and Wildlife (WDFW), April 7, 2008, Correspondence between Monica Tonel, EPA Region 10, and Eric Pentico, WDFW Habitat Biologist.

Western Regional Climate Center (WRCC) retrieved December 18, 2007 http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wa5613

Whiteman, K.J., Vaccaro, J.J., Gonthier, J.B., and Bauer, H.H., 1994, The Hydrogeologic Framework and Geochemistry of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho, U.S. Geological Survey Professional Paper 1413-B.

A Photographic Documentation

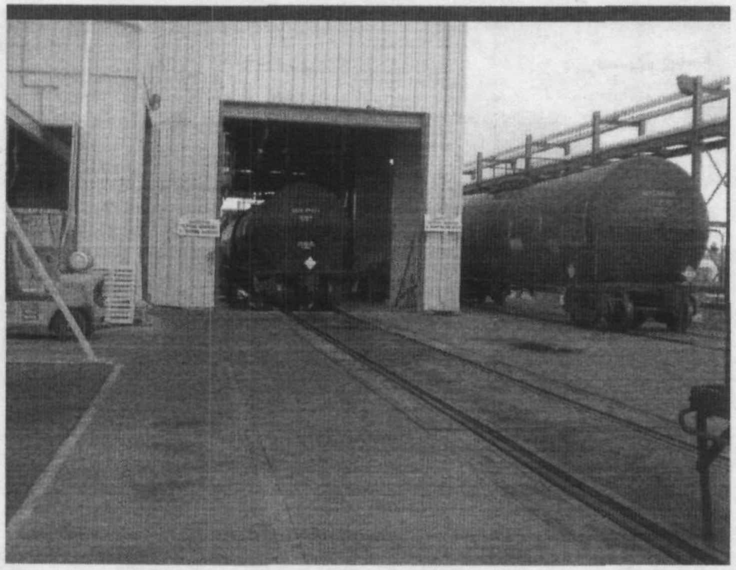


Photo 1 Rail car area. Location of May 2007 spill.

Direction: North Date: 2/14/2008 Time: 10:56

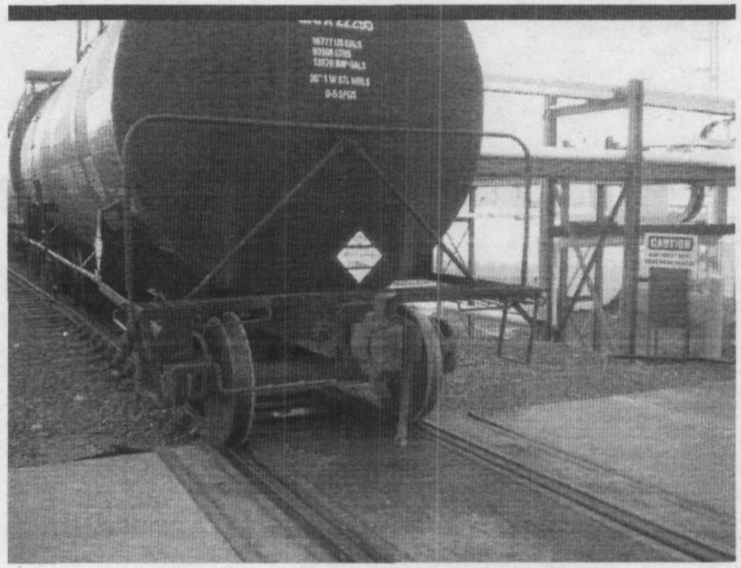


Photo 2 Rail car area. Location of May 2007 spill.

Direction: South Date: 2/14/2008 Time: 10:57

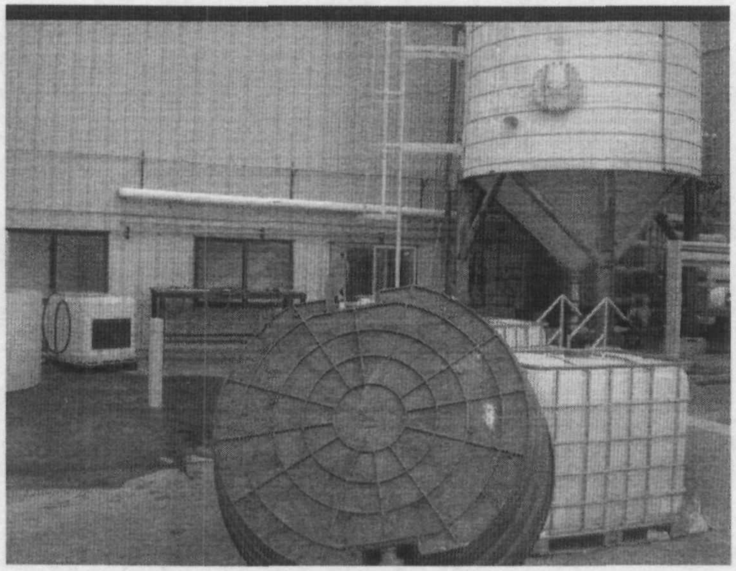


Photo 3 Chemical storage area.

Direction: North Date: 2/14/2008 Time: 11:06

Photo 4 450,000 gallon collection pond.

Direction: Southwest Date: 2/14/2008 Time: 11:08

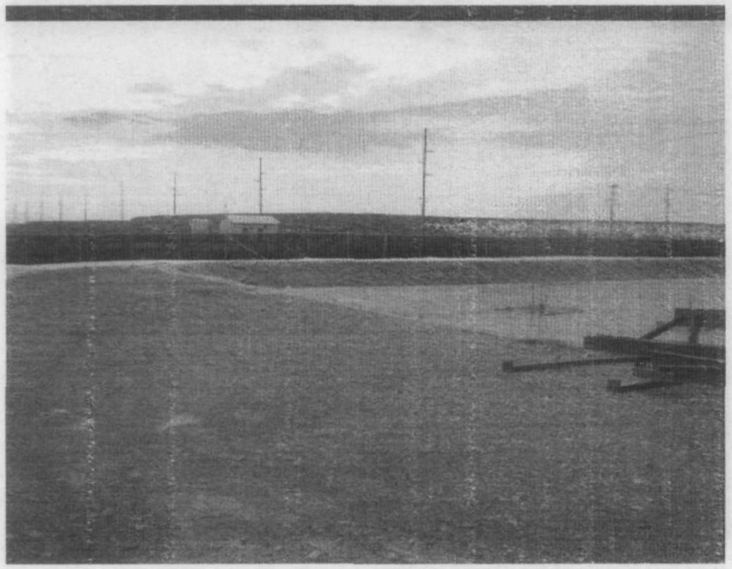


Photo 5 450,000 gallon collection pond. City Well #17 in background.

Direction: Southwest Date: 2/14/2008 Time: 11:11

Photo 6 Loading area, location of December 2007 explosion.

Direction: North Date: 2/14/2008 Time: 11:17

Photo 7 Surface water drainage ditch.

Direction: Northeast Date: 2/14/2008 Time: 11:19

Photo 8 Surface water drainage ditch.

Direction: North Date: 2/14/2008 Time: 11:20

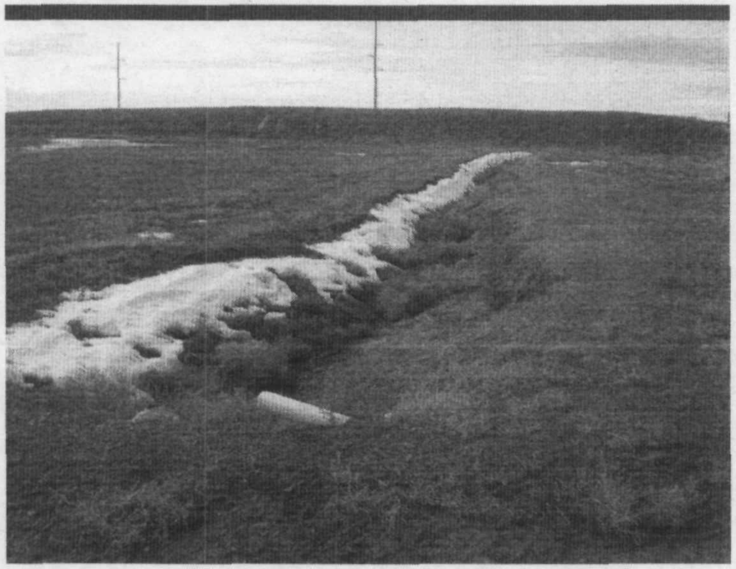


Photo 9 Surface water drainage ditch with planned NPDES outfall pipe.

Direction: Southwest Date: 2/14/2008 Time: 11:22

B Standard Operating Procedures

Title:	BOREHOLE SAMPLING
Category:	ENV 3.3
Revised:	April 1998

STANDARD OPERATING PROCEDURE

BOREHOLE SAMPLING

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TITLE:	BOREHOLE SAMPLING		
CATEGORY:	ENV 3.3	**REVISED:**	April 1998

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Introduction

1.1 Scope

This document presents an in-depth discussion of the techniques used to obtain subsurface soil samples from boreholes.

1.2 Objectives

Most subsurface investigations require the drilling of boreholes for one or more purposes, including: collection of soil samples for lithologic logging and laboratory testing; lithologic and hydrogeologic characterization using borehole geophysical logging; and installation of piezometers or monitoring wells. Drilling methods are selected based on availability and cost; suitability for the type of geologic materials at a site (unconsolidated or consolidated); and possible effects on sample integrity (potential influence of drilling fluids and for cross contamination between aquifers).

A wide variety of drilling methods have been developed that may be suitable for one or more of the purposes described above. Table 1 summarizes information on 21 drilling methods. The hollow-stem auger (HSA) is the most commonly used method for well installation in unconsolidated deposits. Air rotary drilling is probably the most commonly used method for well installation in consolidated formations. Table 2 provides information on the relative performance of 11 of the drilling methods listed in Table 1 for different types of geologic formations. Subsurface soil samples are collected from boreholes for chemical and physical analysis, and to aid in the definition and tracking of contaminants in the soil. The type subsurface soil sample may be either undisturbed or disturbed. and either composite or discrete. The type of sample to be collected depends on the purpose of the investigation and the drilling technique.

2. Drilling and Sampling Techniques

The most accurate method for obtaining information on the characteristics of unconsolidated deposits is to collect representative samples of soil at measured depths and at intervals that will provide a complete stratigraphic and lithologic profiles of soils and bedrock, respectively. For most boreholes, subsurface soil samples are collected continuously, at 2- or 5-foot intervals, or at every change in the formation.

Table 1 Summary Information on Drilling Methods

Drill Method	Casing/Open Hole	Fluids Affect Chem.?	Core Samples?
Open-Hole Rotary Methods			
Hollow-Stem Auger	Open hole	Usually no fluids	Possible
Direct Air Rotary with Bit	Open hole	Yes	Possible
Direct Air Rotary with Downhole hammer	Open hole	Yes	Possible
Direct Mud Rotary	Open hole	Yes	Possible
Reverse Rotary (no casing)	Open hole	Yes	Possible
Cable Tool	Either	Usually no	Possible
Rotary Drill-Through Methods			
Rotary Casing Driver	Casing	Yes	Possible
Dual Rotary Advancement	Casing	Yes	Possible
Reverse Circulation Methods			
Reverse Duel Wall Rotary	Casing	Yes	Possible
Reverse Duel Wall Percussion	Casing	Yes	Possible
Hydraulic Percussion	Casing	Yes	Possible
Downhole Casing Advancers	Casing	Yes	Possible
Jet Percussion	Casing	Possible	Possible
Jetting	Open hole	Possible	No
Solid-Stem Auger	Open hole	No	Possible
Bucket Auger	Open hole	No	Possible
Rotary Diamond	Open hole	Possible	Yes
Directional Drilling	Either[a]	Possible	Possible[a]
Sonic Drilling	Either	Possible	Yes
Driven Wells	Either	No	No
Cone Penetration	Open hole	No	Possible[b]

[a] Sampling with a device resembling a split spoon may be possible with some directional rigs.
[b] Geoprobe has developed a core sampler for use with a cone penetrometer type (CPT) rig.

Key:

Shading indicates most commonly used methods for monitoring well installation.

Table 2 Relative Performance of Different Drilling Methods in Various Types of Geologic Formations

Type of Formation	Cable Tool	Direct Rotary (with fluids)	Direct Rotary (with air)	Direct Rotary (Down-the-hole-air hammer)	Direct Rotary (Drill-through casing hammer)	Reverse Rotary (with fluids)	Reverse Rotary (Dual Wall)	Hydraulic Percussion	Jetting	Driven	Auger
Dune sand	2	5	NR	NR	6	5[a]	6	5	5	3	1
Loose sand and gravel	2	3-5	NR	NR	6	5[a]	6	5	5	3	1
Quicksand	2	5	NR	NR	6	5[a]	6	5	5	NR	1
Loose boulders in alluvial fans or glacial drift	3-2	2-1	NR	NR	5	2-1	4	1	1	NR	1
Clay and silt	3	5	NR	NR	5	5	5	3	3	NR	3
Firm shale	5	5	NR	NR	5	5	5	3	NR	NR	2
Sticky shale	3	5	NR	NR	5	3	5	3	NR	NR	2
Brittle shale	5	5	NR	NR	5	5	5	3	NR	NR	NA
Sandstone—poorly cemented	3	4	NR	NR	NA	4	5	4	NR	NR	NA
Sandstone—well cemented	3	3	5	NR	NA	3	5	3	NR	NR	NA
Chert nodules	5	3	3	NR	NA	3	3	5	NR	NR	NA
Limestone	5	5	5	6	NA	5	5	5	NR	NR	NA
Limestone with chert nodules	5	3	5	6	NA	3	3	5	NR	NR	NA
Limestone with small cracks or fractures	5	3	5	6	NA	2	5	5	NR	NR	NA
Limestone, cavernous	5	3-1	2	5	NA	1	5	1	NR	NR	NA
Dolomite	5	5	5	6	NA	5	5	5	NR	NR	NA
Basalts, thin layers in sedimentary rocks	5	3	5	6	NA	3	5	5	NR	NR	NA
Basalts—thick layers	3	3	4	5	NA	3	4	3	NR	NR	NA
Basalts—highly fractured (lost circulation zones)	3	1	3	3	NA	1	4	1	NR	NR	NA

Table 2 Relative Performance of Different Drilling Methods in Various Types of Geologic Formations

Type of Formation	Cable Tool	Direct Rotary (with fluids)	Direct Rotary (with air)	Direct Rotary (Down-the-hole-air hammer)	Direct Rotary (Drill-through casing hammer)	Reverse Rotary (with fluids)	Reverse Rotary (Dual Wall)	Hydraulic Percussion	Jetting	Driven	Auger
Metamorphic rocks	3	3	4	5	NA	3	4	3	NR	NR	NA
Granite	3	3	5	5	NA	3	4	3	NR	NR	NA

[a] Assuming sufficient hydrostatic pressure is available to contain active sand (under high confining pressures).

Rate of Penetration:

1 = Impossible
2 = Difficult
3 = Slow
4 = Medium
5 = Rapid
6 = Very rapid

Key:

NA= Not applicable.
NR= Not recommended.

Source: Driscoll (1986).

2.1 Disturbed and Undisturbed Samples

Soil samples from unconsolidated deposits can be collected as disturbed or undisturbed soil samples. Disturbed soil samples are produced by HSA drilling and are therefore referred to as drill cuttings. The components of a HSA are shown in Figure 1. Disturbed samples are not representative of the formations penetrated because of the possible sorting and grinding of the cuttings while being carried to the surface. In general, disturbed samples do not contain detailed lithologic information, and the depth at which the soil is encountered is not precisely known. Undisturbed soil samples are collected by a variety of sampling devices, including the split-barrel sampler (see Figure 2), the Laskey sampler (see Figure 3), and the Shelby tube sampler. The collection of undisturbed samples helps to ensure the preservation of detailed lithologic information such as the degree of consolidation, sorting, bedding, etc., and provides a more accurate determination of sample depth.

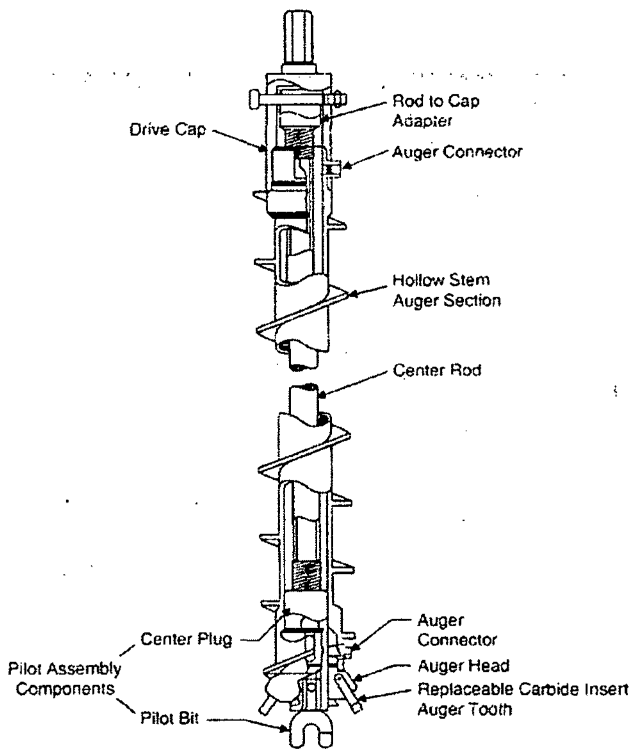


Figure 1 Typical Components of a Hollow-Stem Auger

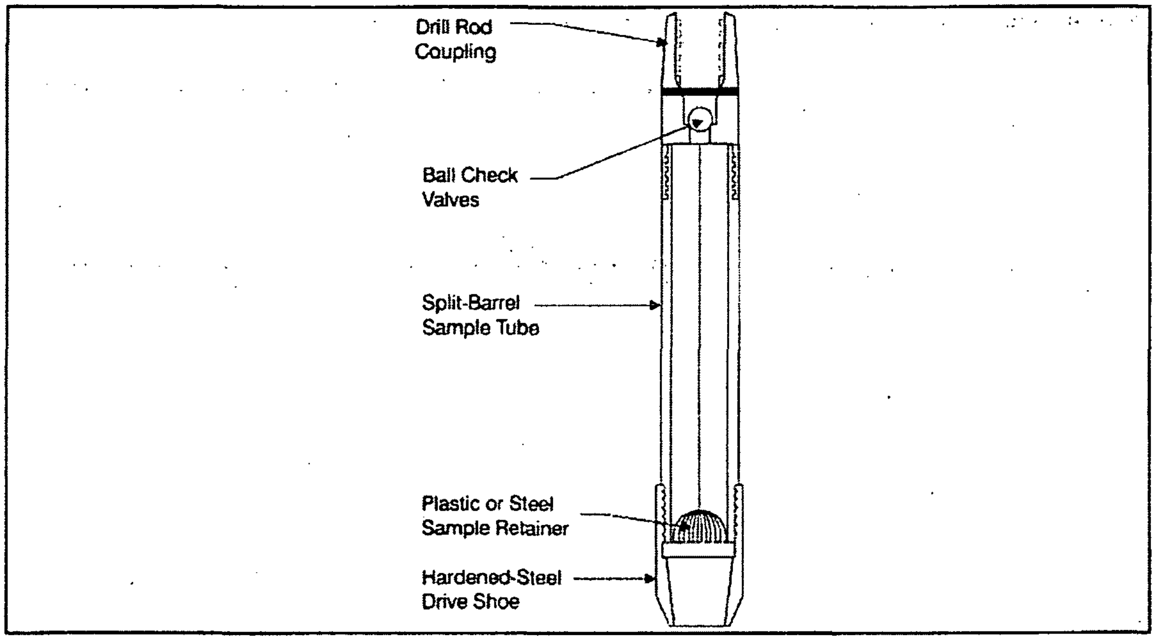


Figure 2 Split-Spoon or Split-Barrel Sampler

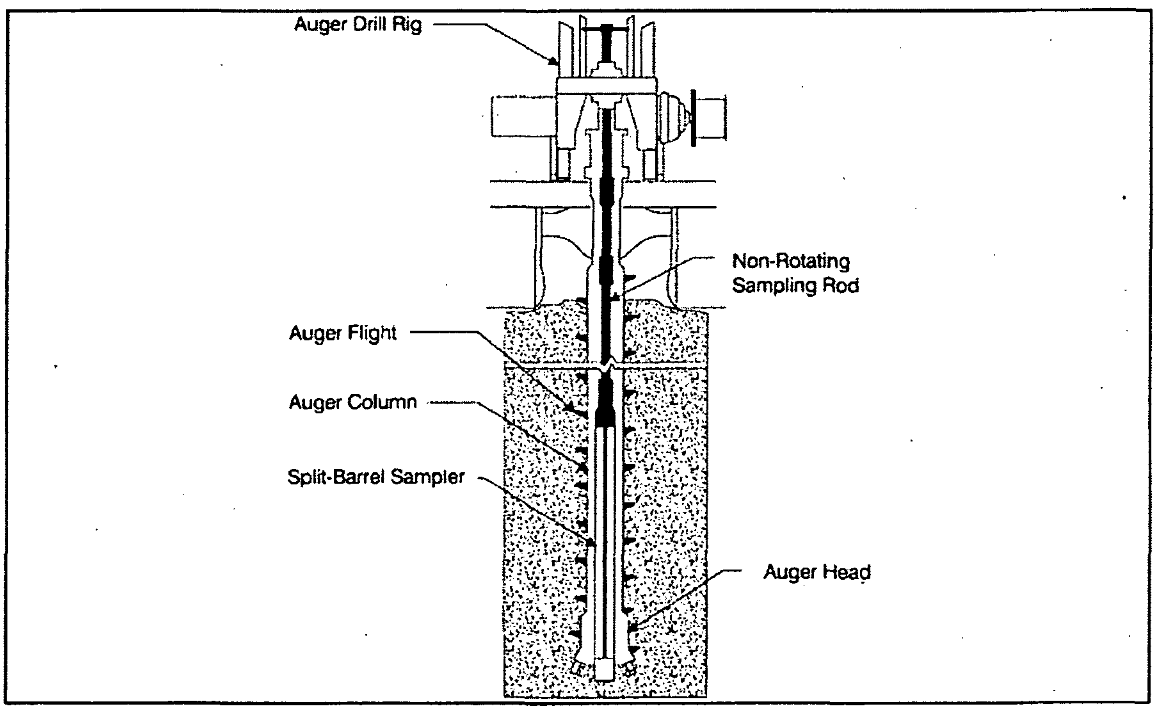


Figure 3 Continuous Sampling Tube System

2.2 Discrete and Composite Samples

Discrete samples are obtained from a specific depth and are used when detailed analytical information about overburden soils is required. Analysis of discrete unconsolidated soil samples provides more accurate information on the depth of contamination.

Composite samples are prepared from aliquots of discrete samples. They are used for obtaining a representative sample from a subsurface interval for analytical purposes. Composite samples are not appropriate for use in stratigraphic description.

3. Borehole Drilling

3.1 Inspection and Cleaning of Sampling Equipment

Proper cleaning, including steam-cleaning, of the drill rig, down-hole equipment, and sampling equipment, should be performed upon arriving at the site and between drilling locations. This is necessary to minimize the potential introduction of contaminants into unconsolidated soil samples. The drill rig should also be checked repeatedly for oil and hydraulic fluid leaks. These precautions are essential to ensure that contaminants from the drilling process are not introduced into the samples. If specified in the site-specific work plan (SSWP), all non-disposable sampling equipment may need to be decontaminated according to specific procedure referenced in the SSWP.

3.2 Hollow-Stem Auger Drilling

A HSA column simultaneously rotates and axially advances by a mechanically or hydraulically powered drill rig. The hollow stem of the auger allows the use of various methods for continuous or intermittent sampling of subsurface soils. HSA columns are manufactured in 5-foot lengths and have inside diameters (IDs) ranging from 2.25-inch ID to 10.25-inch ID. Drilling with augers of different diameters makes possible the use of casings to isolate near-surface contamination while drilling continues with a smaller-diameter auger. In addition, the riser and screen for monitoring wells can be placed in the HSAs when the desired depth of drilling has been reached, and filter pack and grouting can be emplaced as the HSAs are gradually withdrawn from the hole.

If a split-barrel soil sampler is used to collect samples from unconsolidated deposits, a center plug with the same diameter as the HSAs, and a section of drilling rod are placed inside the lead flight. The HSAs are advanced through the unconsolidated deposit to the first sampling interval, and the center plug is then removed from the HSA. A precleaned split-barrel soil sampler is attached to the end of the drilling rod and lowered into the HSAs. A safety hammer is attached to the top of the drilling rod and the split-barrel soil sampler is driven into the undisturbed soil in an increment of 2 feet. The split-barrel soil sampler is then raised and opened to remove the soil sample. The center plug is then re-placed into the HSAs, and another HSA flight is attached to the top of the flight already in the ground. The process is repeated until bedrock is encountered or the project depth is reached.

A Laskey soil sampler is used to collect a continuous 5-foot soil sample while the HSAs are turning. The Laskey soil sampler is used instead of a center plug in 4.25-inch HSAs, and the head of the sampler is advanced ahead of the HSAs by 2 to 6 inches. Upon completion of a 5-foot run of HSAs, the Laskey soil sampler is recovered and opened in a manner similar to a split-barrel sampler. Following sample collection and decontamination of the Laskey soil sampler, the sampler is re-placed into the HSAs, and another flight of HSAs is attached to the top of the flight already in the ground.

A Shelby tube sampler is used to collect samples of undisturbed overburden usually for collection of geotechnical samples. Shelby tubes are available in a variety of diameters and lengths. The most common Shelby tubes are 3 to 5 inches I.D. and 18 to 30 inches long. Once the HSAs have reached the top of the interval to be sampled, the drilling rods holding the center plug are withdrawn from the HSAs. The Shelby tube is then attached to the end of the drilling rod and lowered into the HSAs. The Shelby tube is "pushed" out the bottom of the HSAs to the prescribed depth and then retrieved. The tube is not opened in the field; the ends are sealed (with wax) and it is shipped to the laboratory intact. The process is repeated until bedrock is encountered or the project depth is reached.

3.3 Direct Air Rotary, Mud Rotary, and Downhole Hammer Drilling

The basic rig setups for air or mud rotary with tri-cone or roller-cone bit are similar, except for the circulation medium used. Compressed air or mud is circulated down through the drill rods to cool the bit and carry cuttings up the hole to the surface. For air rotary drilling, a cyclone separator is used to slow the air velocity and allow the cuttings to fall into a container. A down-the-hole hammer, which operates with a percussive (pounding) action as it rotates, is used for air rotary drilling. For mud rotary drilling, a tri-cone roller bit is used.

3.4 Cable Tool Drilling

Cable tool drilling rigs operate by repeatedly lifting and dropping a heavy string of drilling tools attached to a cable into the borehole. Consolidated rock is broken or crushed into small fragments, and unconsolidated material is loosened by the drill bit. The reciprocating action is caused by attaching the cable to an eccentric walking or spudding beam that also serves to mix the crushed or loosened particles with water to form a slurry at the bottom of the borehole. Periodically, the drilling string is removed and the slurry is removed by a sand pump or bailer. In unconsolidated formations, a casing is driven into the ground to keep the hole open.

A sample of cable tool cuttings should include more than one bailer load of material to provide a composite sample that is reasonably representative of the sampling interval. This is particularly important when sampling sand and gravel formations. The cable tool drilling method is not as common a method for installing monitoring wells as it once was.

3.5 Other Methods for Collecting Shallow Subsurface Soil Samples

Several methods are available for obtaining shallow subsurface soil samples (less than 10 feet) without using a drill rig.

- Hand Augers. These are useful for obtaining samples from shallow depths in unconsolidated formations. Samples are collected from a bucket auger advanced by hand through shallow depth intervals.

- Power Augers. These are usually hand augers powered by a gasoline engine. Disturbed soil samples are collected from the auger flight as the tool is turned.

- Backhoes. Backhoes are relatively inexpensive and can excavate a slit trench up to 12 feet deep very quickly. Samples can be obtained by attaching a Shelby tube to the bucket or by collecting samples directly out of the bucket.

- Geoprobe. This is a truck- or van-mounted hydraulic unit which pushes or hammers a small diameter probe into shallow, unconsolidated soils. The unit can be used to collect samples of subsurface soils, soil gas, or groundwater.

4. Borehole Abandonment

Borehole abandonment is necessary to eliminate potential physical hazards, to prevent groundwater contamination, to conserve aquifer yield and hydrostatic head, and to prevent intermixing of subsurface water. After the necessary unconsolidated soil samples or consolidated core samples have been collected from the borehole, the HSAs are removed from the borehole and the HSA flights are cleaned and appropriately decontaminated. A cement/bentonite grout should be tremied into the borehole to the surface. The grout should consist of potable water, bentonite powder, and Type I portland cement, with 94 pounds of cement and 5 pounds of bentonite per 6.5 gallons of water. In certain areas, specific borehole or well abandonment methods are specified in the associated environment regulations and these methods must be adhered to.

5. Disposal of Drill Cuttings and Decon Liquids

5.1 Containerization of Drill Cuttings and Decon Liquids

Drill cuttings must be handled as outlined in the work plan for the site. In some instances, the drill cuttings are classified as hazardous waste under the Resource Conservation and

Recovery Act (RCRA) and must be placed in U.S. Department of Transportation (DOT)-approved 55-gallon steel drums pending analysis. The drums of drill cuttings must be properly labeled and marked with the contents, date, and source of the drill cuttings (e.g., "MW-2") prior to being staged.

Decon fluids may also be placed in DOT-approved 55-gallon steel drums pending analysis. The drums of decon liquids must be properly labeled and marked with the type and source of the fluids and the date the drum was filled prior to being staged.

In instances when field monitoring for the presence of contaminants in soil and water is performed, approval for not containerizing investigation-derived soil and water may be approved by the local regulatory agency. This approval must be obtained prior to the commencement of the field investigation.

5.2 Disposal of Drill Cuttings and Decon Liquids

Upon receipt of the analytical results, the drill cuttings and decon liquids can be properly classified. It is the responsibility of the property owner and/or client to arrange for the disposal of the drill cuttings and fluids at an approved facility.

6. Bibliography

Acker, W.L. 1974, Basic Procedures for Soil Sampling and Core Drilling. Acker Drill Co., Scranton, PA.

American Petroleum Institute (API), 1973, Procedures for Selecting Rotary Drilling Equipment, 2nd edition. API Bulletin D10. API, Washington, DC.

American Society for Testing and Materials (ASTM), 1980, Standard Practice for Soil Investigation and Sampling by Auger Borings, D1452-80, (Vol. 4.08), ASTM, Philadelphia, PA.

American Society for Testing and Materials (ASTM), 1993, Draft Standard Guide for the Use of Hollow-Stem Augers for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices, D18.21 Ballot 93-03, ASTM Philadelphia, PA.

Corps of Engineers, 1972, Soil Sampling, EM 1110-2-1907, COE, Department of the Army, Washington, DC.

Driscoll, F.G., 1986, *Groundwater and Wells,* 2nd ed.

Hackett, G. 1987, Drilling and Constructing Monitoring Wells with Hollow Stem Augers: Part 1, Ground Water Monitoring Review 7(4):51-62.

U.S. Army, 1981, Well Drilling Operations, Department of Army Technical Manual FM5-11-61/AFR 85-23.

U.S. Army Toxic and Hazardous Material Agency (USATHAMA), 1982, Minimum Requirement for Boring Logs, Drilling Procedures, Monitoring Well Installation, and Associated Data Management System Entries, USATHAMA, Aberdeen Proving Ground, MD.

Title:	FIELD ACTIVITY LOGBOOKS
Category:	DOC 2.1
Revised:	April 1998

STANDARD OPERATING PROCEDURE

FIELD ACTIVITY LOGBOOKS

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TITLE:	FIELD ACTIVITY LOGBOOKS		
CATEGORY:	DOC 2.1	REVISED:	April 1998

TABLE OF CONTENTS

1. Summary

This Standard Operating Procedure (SOP) establishes requirements for the entry of information into logbooks to ensure that E & E field activities are properly documented. The project manager (PM) and the field team leader (FTL) are responsible for ensuring that logbook entries provide sufficient information for the completion of an accurate and detailed description of field operations and meets the requirements of the contract or technical direction document (TDD).

This SOP describes logbook entry requirements for all types of projects, specifies the format that should be used, and provides examples. Some flexibility exists when implementing the SOP because different types of projects require different data collection efforts. This SOP does not address site safety logbook requirements or geotechnical logbook entries.

2. Purpose

Complete and accurate logbook entries are important for several reasons: to ensure that data collection associated with field activities is sufficient to support the successful completion of the project; to provide sufficient information so that someone not associated with the project can independently reconstruct the field activities at a later date; to maintain quality control (QC) throughout the project; to document changes to or deviations from the work plan; to fulfill administrative needs of the project; and to support potential legal proceedings associated with a specific project.

2.1 Adequate Field Information/Quality Control

QC procedures for data collection begin with the complete and systematic documentation of all persons, duties, observations, activities, and decisions that take place during field activities. It is especially important to fully document any deviations from the contract, project scope, work plans, sampling plans, site safety plans, quality assurance (QA) procedures, personnel, and responsibilities, as well as the reasons for the deviations.

Prior to entering the field, the project manager must indicate to the field team what pertinent information must be collected during field activity in order to meet the desired objectives of the data collection effort. The PM is responsible for reviewing the adequacy of the project logbooks both during and following completion of field activities, and is also responsible for meeting with the field team members to discuss any findings and to direct activities to correct any deficiencies, as appropriate. The PM also has the responsibility of ensuring that the logbooks become part of the project or TDD file.

2.2 Work Plan Changes/Deviation

The logbook is the document that describes implementation of the work plan and other appropriate contract documents and provides the basis for the project reports. It must include detailed descriptions of any and all deviation from the work plan and the circumstances that necessitate such changes. These changes will be reviewed for compliance with data quality objectives and include:

- Changes in procedures agreed to in the project planning stages;
- Any conditions that prevent the completion of the field effort, or that result in additional fieldwork must be noted (i.e., weather delays, government actions, physical obstructions, personnel/ equipment problems, etc.). Persons from whom permission was obtained to make such changes must be clearly documented.
- Any modifications requested by the client or client's representative that are contradictory to the contract or outside of the existing scope of work must be documented in detail because the cost of the project could be affected by such modifications.

2.3 Evidentiary Documentation

Field activity documentation can become evidence in civil and/or criminal judicial proceedings, as well as in administrative hearings. Field logbooks serve this purpose. Accordingly, such documentation is subject to judicial or administrative review. More importantly, it is subject to the review of an opposing counsel who will attempt to discredit its evidentiary value.

The National Enforcement Investigation Center (NEIC) and the United States Environmental Protection Agency (EPA) have prepared documents outlining their documentation needs for legal proceedings. These guidelines indicate the importance of accurate and clear documentation of information obtained during the inspections, investigations, and evaluations of uncontrolled hazardous waste sites. Consequently, attention to detail must be applied by E & E personnel to all field documentation efforts for all E & E projects. Project personnel must document where, when, how, and from whom any vital project information was obtained. This information is necessary to establish a proper foundation for admissible evidence.

3. Guidelines

Logbooks should contain a summary of any meeting or discussion held with a client or with any federal, state, or other regulatory agency that was on site during the field activities. The logbook should also describe any other personnel that appear on site, such as representatives of a potential responsible party (PRP).

The logbook can be used to support cost recovery activities. Data concerning site conditions must be recorded before the response activity or the passage of time eliminates or alters those conditions. Logbooks are also used to identify, locate, label, and track samples and their final disposition. In addition, data recorded in the logbook will assist in the interpretation of the analytical results.

Logbooks are subject to internal and external audits. Therefore, the recorded information should be consistent with and capable of substantiating other site documentation such as time cards, expense reports, chain-of-custody forms, shipping papers, and invoices from suppliers and subcontractors, etc. Logbooks also act as an important means of reconstructing events should other field documents such as data collection forms become lost or destroyed. Therefore, all mission-essential information should be duplicated in the logbook.

3.1 General Instructions

The following general guidelines must be used for all logbooks:

- At a minimum, one separate field activity logbook must be maintained for each project or TDD.
- All logbooks must be bound and contain consecutively numbered pages.
- No pages may be removed for any reason, even if they are partially mutilated or illegible.
- All field activities must be recorded in the site logbook (e.g., meetings, sampling, surveys, etc.).
- All information must be **printed legibly** in the logbook using waterproof ink, preferably black. If weather conditions do not permit this (i.e., if it is too cold or too wet to write with ink), another medium, such as pencil, may be used. The reason that waterproof ink was not used should be specifically noted in the logbook.
- The language used in the logbook should be objective, factual, and free of personal feelings or terminology that might prove inappropriate.
- Entries should be made in chronological order. Contemporaneous entries are always preferred because recollections fade or change over time. Observations that cannot be recorded during field activities should be recorded as soon after as possible. If logbook entries are not made during field activities, the time of the activity/ observation and the time that it is recorded should be noted.
- The first entry for each day will be made on a new, previously blank page.
- Each page should be dated and each entry should include the time that the activity occurred based on the 24-hour clock (e.g., 0900 for 9 a.m., 2100 for 9 p.m.).
- At the completion of the field activity, the logbook must be returned to the permanent project or TDD file.

3.2 Format

The information presented below is not meant to be all-inclusive. Each project manager is responsible for determining the specific information requirements associated with a field activity logbook. If someone other than the Project Manager is keeping the logbook, the Project Manager is responsible to convey to that individual, prior to the start of fieldwork, specific instructions on what type of information is required to be entered into the logbook. Information requirements will vary according to the nature and scope of the project. (Refer to Appendix A for an example of a completed logbook.)

Title Page

The logbook title page should contain the following items:

- Site name,
- Location,
- TDD No. or Job No.,
- PAN (an EPA site/task identification number), if applicable,
- SSID No. (Site ID number-assigned under CERCLA), if applicable,
- Start/Finish date, and
- Book ___ of ___.

First Page

The following items should appear on the first page of the logbook prior to daily field activity entries:

- TDD No. or Job No.,
- Date,
- Summary of proposed work (Reference work plan and contract documents, as appropriate),
- Weather conditions,
- Team members and duties, and
- Time work began and time of arrival (24-hour clock).

Successive Pages

In addition to specific activity entries and observations, the following items should appear on every logbook page:

- Date,
- TDD or Job No., and
- Signature (bottom of each page). If more than one person makes entries into the logbook, each person should sign next to his or her entry.

Last Page

In addition to specific activity entries and observations and the items that should appear on each successive page, the last page of the logbook should contain a brief paragraph that summarizes the work that was completed in the field. This summary can become especially important later on if more or less work was accomplished during the duration of the field activity.

3.3 Corrections

If corrections are necessary, they must be made by drawing a single line through the original entry in such a manner that it can still be read. *Do not erase or render an incorrect notation illegible.* The corrected entry should be written beside the incorrect entry, and the correction must be initialed and dated. Most corrected errors will require a footnote explaining the correction.

4. Documentation

Although the requirements and content of the field logbook will vary according to the site and the tasks to be performed, the following information should be included in every logbook:

4.1 Prior to Fieldwork

Summary of Proposed Work

The first paragraph of **each** daily entry should summarize the work to be performed on that day. For example:

> "Collect soil and groundwater samples from previously installed wells and ship samples to Analytical Services Center (ASC). Discuss removal with site owner."

The first paragraph becomes especially important later when discussing work plan deviations or explaining why more or less work was accomplished for that day.

Personnel

Each person to be involved in activities for the day, his/her respective role (sampler, health and safety, etc.), and the agency he/she represents should be noted in the logbook.

On-Site Weather Conditions

Weather conditions may have an impact on the work to be performed or the amount of time required to perform the proposed work; therefore, all weather on-site weather conditions should be noted, including temperatures, wind speed and direction, precipitation, etc., and updated as necessary. Similarly, any events that are impacted by weather conditions should be noted in the logbook.

Site Safety Meeting

Although minutes should be recorded for all site safety meetings under separate cover, the logbook should briefly summarize the site safety meeting and any specific site conditions and resultant site safety concerns.

4.2 Site Sketch

A site sketch should be prepared on the first day of field activities to indicate prominent site and environmental features. The sketch should be made either to scale or by noting the approximate distances between site feature. Area-specific sketches should be prepared as work is undertaken in such areas, and updated sketches should be drawn as work progresses.

Site Features

Examples of features to be noted on the site sketch include the following:

- Structures such as buildings or building debris;
- Drainage ditches or pathways, swales, and intermittent streams (include direction of overland runoff flow and direction of stream flow);
- Access roads, site boundaries, and utility locations;
- Decontamination and staging areas;
- Adjacent property data: the type of property that borders the site, information pertaining to ownership, and available addressees; and
- North arrow.

Changes in Site Conditions

Any deviation from previous site sketches or drawings presented in the work plan, and any changes that have occurred since the last site visit must be noted. Differences to be noted include the following:

- Demolished buildings;
- Changes to access routes;
- Damage to wells or equipment, or changes to the amount of such equipment believed to be on site,
- Changes resulting from vandalism;
- Destruction of reference points;
- Changes resulting from environmental events or natural disasters; and
- Locations of excavations, waste piles, investigation-derived waste (IDW), drum staging areas, etc.

In short, *any* site condition that varies from the conditions described in the work plan should be noted.

4.3 Monitoring Equipment and Activities

Any monitoring equipment used during field activities should be documented in the logbook. Information to be noted includes:

- The type of equipment with model and serial numbers. (HNu, OVA, etc.);
- The frequency at which monitoring is performed;
- Calibration results and the frequency at which the equipment is calibrated or tested;
- Background readings;
- Any elevated or unusual readings; and
- Any equipment malfunctions.

It is particularly important to note elevated or unusual equipment readings because they could have an impact on personal protection levels or the activities to be performed on site. If a change in the proposed work or protection levels occurs, it should be clearly noted in the logbook.

4.4 Sample Collection Activities

Because it represents the first step in an accurate chain-of-custody procedure, field sampling documentation must be complete. The following items should be documented in the logbook:

Sample Collection Procedures

The following items pertaining to sample collection procedures should be included in the logbook:

- Any pre-sampling activities (i.e., well purging and the number of volumes purged before sample collection);
- Results of the pre-sampling activities (i.e., pH/conductivity/ temperature readings for well water, results of hazard categorization testing, etc.);
- Any environmental conditions that make sample collection difficult or impossible (i.e., dry or flooded drainage paths, inclement weather conditions, etc.); and
- Any deviation from the work plan (i.e., additional samples and the reason for their collection, alternate sample locations, etc.).

Sample Information

The following information regarding sample data should be recorded in the logbook:

- Sample number and station location including relationship to permanent reference point(s);
- Name(s) of sampler(s);
- Sample description and any field screening results;
- Sample matrix and number of aliquots if a composite sample;
- Preservatives used, recipient laboratory, and requested analyses;
- QA/QC samples; and
- Shipping paper (airbill) numbers, chain-of-custody form numbers, and jar lot numbers.

Investigation-Derived Waste/Sample Shipment

Details pertaining to sampling equipment, decontamination, and IDW should be clearly delineated in the work plan. However, the following information should be included in the log-book:

- The type of IDW generated an the number of containers generated (each drum should be numbered and its contents noted);
- All information relevant to the characterization of the IDW;
- Any directions received from the client/workplan/contract relative to the management of the IDW;
- The disposition of IDW (left on site or removed from site);
- The number of sample containers shipped to the ASC or laboratory and the courier used (i.e., Federal Express, Airborne Express, etc.);
- Airbill or shipment tracking numbers; and
- The type of paperwork that accompanied the waste/sample shipment (e.g., manifests, etc.).

4.5 Photodocumentation

Photographs should be taken during all relevant field activities to confirm the presence or absence of contaminants encountered during fieldwork. Specific items to be documented in-clude:

- Sample locations and collection activities;
- Site areas that have been disturbed or impacted, and any evidence of such impacts (i.e., stressed vegetation, seepage, discolored water, or debris);
- Hazardous materials requiring disposal, including materials that may not appear in the work plan;
- Any evidence that attests to the presence or absence of contamination; and
- Any features that do not appear in the work plan or differ from those described in the work plan.

Documentation of any photographs taken during the course of the project must be provided in the logbook with a detailed description of what is shown in the photograph and the reason for taking it. This documentation should include:

- Make, model, and serial numbers of the camera and lens,
- Film type and number of exposures,
- Roll and frame number of the photograph;
- Direction or view angle of the photograph, and
- Name of the photographer.

4.6 Data Collection Forms

Certain phases of fieldwork may require the use of project-specific data collection forms, such as task data sheets or hazard categorization data sheets. Due to the specific nature of these forms, the information that should be included in the logbook cannot be fully discussed in this SOP. However, the following data should be included in the logbook:

- Results of any field tests or hazard categorization tests (i.e., ignitability, corrosivity, reactivity, etc.);
- The source from which any field sample was collected and its condition (i.e., drum, tank, lagoon, etc.).
- Other conclusions as a result of the data collected on data collection forms.

In many cases, rubber stamps that contain routine data collection forms can be manufactured ahead of time. These forms can be stamped into the logbook on an as-needed basis.

Appendix A

Sample Logbook

WEDNESDAY JANUARY 26, 1994

PROPOSED WORK FOR DAY: COLLECT GROUNDWATER SAMPLES FROM WELLS AND PIEZOMETERS AT SITE 1 AND SITE 3. SHIP SAMPLES TO THE ASC. CONTAINERIZE PURGE WATER. MEET WITH FRED CANSLER AND DISCUSS REMOVAL OF CANOPIES AT SITES 1 AND 3 AND FILLING OF EXCAVATIONS.

WEATHER ON SITE: CLOUDY AND WARM WITH A HIGH TEMPERATURE OF 50° F. RAIN SHOWERS WITH WINDS FROM THE SW AT 5-15 MPH.

E&E PERSONNEL ON SITE: G. JONES, J. MAYS, S. MC CUNE

LOG

1330 ARRIVED ON SITE. THE GROUNDWATER SAMPLING CREW WAS PREPARING TO PURGE THE WELLS AND PIEZOMETERS IN THE FIELD ACROSS THE ROAD FROM SITE 1. PURGING OF WELLS BEING COMPLETED WITH HAND BAILERS SINCE PUMP IS INOPERATIVE.

1340 ARRIVED AT SITE 3. MW3-1 AND MW3-5 UNLOCKED AND OPEN; SECURED BOTH WELLS.

 [illegible] 1/26/94

1330 FRED CANSLER ARRIVED ON SITE. DISCUSSED REMOVAL OF CANOPIES AND CLOSURE OF EXCAVATIONS AT SITES 1 AND 3. FRED CANSLER STATED THAT HE HAS A SOURCE FOR THE ROCK AND FOR THE TOP SOIL FOR THE EXCAVATIONS.

1405 ARRIVED AT THE SITE WHERE FRED CANSLER PROPOSES TO REMOVE THE FILL FOR THE EXCAVATIONS. A HILL ON THE WEST SIDE OF THE WARDEN NICKLE IS IN THE PROCESS OF BEING REMOVED. THE ROCK CONSISTS OF WEATHERED SHALE SIMILAR TO THE ROCK REMOVED FROM THE EXCAVATIONS. FRED CANSLER PROPOSES TO USE THE ROCK TO FILL THE EXCAVATIONS TO WITHIN ONE FOOT OF GRADE.

1415 ARRIVED AT THE SITE WHERE FRED CANSLER PROPOSES TO REMOVE TOP SOIL FOR THE EXCAVATIONS. TOP SOIL REMOVED FROM THE YELLOW FREIGHT LOT IS IN PILES ON THE NORTH SIDE OF THE LOT.

1430 RETURNED TO SITE 3. FRED CANSLER WILL ARRANGE TO REMOVE THE CANOPY OVER THE EXCAVATION AT SITE 3 ON THURSDAY MORNING AND WILL ARRANGE TO BRING THE ROCK IN ON THURSDAY AFTERNOON. TWO TRUCKS WILL BE USED TO HAUL THE FILL. THE SUPPORTS HOLDING THE CANOPY

 [illegible] 1/26/94

1430 (Unit) Will Be Cut and the Canopy Dragged
Away From the Excavation.
1445 Contacted Joy Inman From Environics.
Tanker will Be on Site on Thursday
to Pump out the Excavation at Site 3
And on Friday to Remove Water at
Site 1. A Frac Tank will Be Delivered
to Site 1 on Thursday.
1515 Sampling Crew Completed. Packing Samples
Collected at Site 1. All Wells and
Piezometers at Site 1 Have Been Sampled
1530 Sampling Crew Completed Packing Samples
And Securing Drums of Purge Water.
1535 Sampling Crew Departed Site to Deliver
Samples to Federal Express
1600 Contacted Tim Grady From E+E. Discussed
Conversation with Fred Canseca and Status
of Well/Piezometer Sampling.
1615 Secured For Day.

Work Completed: Collected Groundwater Samples
From Site 1 Wells and Piezometers. Discussed
Removal of Canopies and Filling of Excavations
with Fred Canseca. Shipped Samples to ASC

[signature]
1/26/94

THURSDAY JANUARY 27, 1994

Proposed Work for Day: Complete Collection of
Groundwater Samples at Site 3 and Ship the
Samples to the ASC. Remove the Canopies
covering the Excavations at Sites 1 and 3.
Pump the water out of the Excavations at
Sites 1 and 3 and Ship the water off site
to OSCO. Backfill the Excavation at Site 3.
Remove the Drums from the Roll off Box and
Transfer the Drums to the Warehouse.

Weather on Site: Cloudy and Cool with
A High Temperature of 45°F. Winds Variable
10-20 MPH.

E+E Personnel on Site: O. Jones, J. Mays,
S. McCune

LOG
0700 Scott McCune Arrived at Site 3.
0710 Environics Personnel Arrived at Site 3.
0715 Held Site Safety Meeting. Discussed Physical
and Chemical Hazards Associated with Site
and Proposed Work for the Day.
0725 E+E Sampling Team Arrived on Site.

 [signature] 1/27/94

1/27/94 RI6130

0730 E+E SAMPLING CREW COMMENCED COLLECTING SAMPLES AND PURGING MW3-1 AND MW3-2.

0800 FRED CANSLER ARRIVED ON SITE WITH PERSONNEL TO REMOVE THE CANOPY OVER THE EXCAVATION AT SITE 3. THE SUPPORTS WERE CUT AND THE CANOPY WAS DRAGGED AWAY FROM THE EXCAVATION WITH TWO TRACTORS.

0845 THE CANOPY REMOVAL AT SITE 3 COMPLETED AND THE CREW DEPARTED FOR SITE 1.

0850 COMMENCED PUMPING WATER FROM THE EXCAVATION INTO BRYSON TRAILER # 618C'S.

0915 THE E+E SAMPLING TEAM COMPLETED COLLECTING THE GROUNDWATER SAMPLES FROM MW3-1, MW3-2, MW3-3, AND MW3-4. COMMENCED PACKING SAMPLES.

0935 COMPLETED FILLING BRYSON TRAILER # 618CS WITH 5,000 GALLONS OF WATER AND PREPARED MANIFEST # 00941 FOR LOAD. COMMENCED LOADING BRYSON TRAILER # 429.

1000 E+E SAMPLING TEAM DEPARTED THE SITE TO DELIVER SAMPLES TO FEDERAL EXPRESS.

1030 ARRIVED AT SITE 1. THE CANSLER CREW IS IN THE PROCESS OF REMOVING THE CANOPY OVER THE EXCAVATION. CANOPY IS NOT MOVING AS A UNIT.

42 [signature] 1/27/94

RI 6130 1/27/94

1045 RETURNED TO SITE 3. ALL WATER IN THE EXCAVATION HAS BEEN REMOVED EXCEPT FOR THE ICE. BRYSON TRAILER # 429 LOADED WITH 5,200 GALLONS OF WATER. PREPARED MANIFEST # 00942 FOR LOAD. BOTH TANKERS DEPARTED THE SITE.

1100 ENVIRONICS PERSONNEL OPENED THE DRUMS OF DRILLING FLUIDS, DEVELOPMENT WATER AND PURGE WATER AND FOUND THE DRUMS FULL OF ICE. ENVIRONICS WILL CONTACT GARY SHOCKLEY AND RECOMMEND THAT THE DRUMS OF LIQUIDS BE TRANSPORTED TO OSCO FOR TREATMENT SINCE THEY CAN NOT BE BULKED.

1200 CANSLER CREW COMMENCED LOADING TRUCKS WITH STONE FROM THE SITE WEST OF THE WOODEN NICKEL.

1230 ARRIVED AT THE SITE WHERE THE STONE WAS BEING LOADED. THE FILL MATERIAL IS ALL UNDISTURBED WEATHERED BEDROCK.

1245 ARRIVED AT SITE 3. TWO LOADS OF ROCK FILL HAVE BEEN DUMPED IN THE EXCAVATION; AN ESTIMATED FOUR MORE LOADS OF STONE WILL BE NEEDED TO FILL THE EXCAVATION.

1300 ARRIVED AT SITE 1. BRYSON TRAILER # 617

43 [signature] 1/27/94

Title:	GROUNDWATER WELL SAMPLING
Category:	ENV 3.7
Revised:	March 1998

STANDARD OPERATING PROCEDURE

GROUNDWATER WELL SAMPLING

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TITLE:	GROUNDWATER WELL SAMPLING		
CATEGORY:	ENV 3.7	REVISED:	March 1998

TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

1. Introduction

The objective of this Standard Operating Procedures (SOP) document is to provide recommended procedures for the sampling of groundwater wells, and is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. Groundwater sampling procedures appropriate to the project objectives and site conditions will define a sampling event.

Analysis of groundwater samples may determine pollutant concentrations and its risk to public health, welfare, or the environment; extent of contaminants; and confirmation of remedial standards.

2. Scope

This document describes procedures for obtaining representative groundwater samples, quality assurance/quality control (QA/QC) measures to be followed, proper documentation of sampling activities, and recommendations for personnel safety.

3. Method Summary

Before sampling a monitoring well, the well must be purged. This may be done with a number of portable devices, including bailers, submersible pumps, bladder pumps, gas-driven pumps, gas-lift pumps, suction-lift pumps, and inertial-lift pumps. Refer to E & E Standard Operating Procedure for *Groundwater Sampling Devices* (ENV 3.6) for information on different groundwater purging and sampling devices.

A minimum of three well volumes should be removed during well purging to ensure that a representative sample of the groundwater will be sampled. Once the purging is completed and the properly prepared sample containers have been selected, sampling may proceed. Numerous types of sampling devices may be selected for the collection of the groundwater sample, but care should be taken when selecting the sampling device, as some will affect the integrity of the sample.

Sampling should occur in a progression from the least to most contaminated well, if known. Ideally, a dedicated sampling device should be used for each well. However, dedicated sampling devices may not be practical if there are a large number of groundwater samples to be collected. In this case, sampling devices should be cleaned between sampling events using the decontamination procedures outlined in E & E Standard Operating Procedure for *Equipment Decontamination* (ENV 3.15).

4. Sample Preservation, Containers, Handling, and Storage

The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirements (see Table 1). Chemical preservation and cooling of samples to 4 degrees Celsius only retards biological and chemical degradation of contaminants in the sample. Therefore, it is prudent to have the samples delivered to the laboratory as soon as possible following collection.

Sample containers should be precleaned in accordance with U.S. Environmental Protection Agency (EPA) standards and prelabeled, and preservatives should be placed in the containers prior to sample collection. When filling containers, never overfill or prerinse with the water sample, since oil or other substances may remain in the container. For analyses that may require filtered samples (e.g., metals and TOC), the samples should be filtered in the field using one 0.45-micrometer (μm) membrane filter per sample container prior to being preserved.

When all samples have been collected, a field data sheet and a chain-of-custody (C-O-C) form should be completed, and all pertinent data entered in the field logbook. Samples will be placed in a cooler to be maintained on ice at 4 degrees Celsius. Samples must be shipped to arrive at the designated laboratory well before their holding times are reached. It is preferable that these samples be shipped or delivered daily to the laboratory as outlined in the E & E Standard Operating Procedure for *Sample Packaging and Shipping* (ENV 3.16).

5. Potential Problems

5.1 General

The primary goal is to obtain a representative analysis of the groundwater body. The analysis can be compromised by field personnel in two primary ways: by collecting an unrepresentative sample, and by incorrect handling of the sample. There are numerous ways that foreign contaminants can be introduced into the sample, and these must be avoided by following strict sampling procedures and utilization of trained personnel.

Table 1 SW-846 Sample Holding Times, Preservation Methods, and Volume Requirements for Water Samples

Protocol Parameter	Holding Time	Minimum Volume	Container Type	Preservation
VOA	14 days from date sampled	One 40-ml vial; no air space	Two 40-ml vials	Add HC1 until pH <2 and ice to 4°C
Semi-VOA (BNAs)	7 days to extract from date sampled	One 1-L jar	1/2-gallon amber glass bottle	Ice to 4°C
PCBs	7 days to extract from date sampled	One 1-L jar	1/2-gallon amber glass bottle	Ice to 4°C
Pesticides and PCBs	7 days to extract from date sampled	One 1-L jar	1/2-gallon amber glass bottle	Ice to 4°C
Metals	6 months from date sampled	One 300-ml bottle	1-L poly bottle	Add $HN0_3$ until pH <2 and ice to 4°C
Cyanide	14 days from date sampled	One 100-ml bottle	1-L poly bottle	Add NaOH until pH >12 and ice to 4°C
Hexavalent chromium	24 hours from time sampled	One 50-ml bottle	125-ml poly bottle	Ice to 4°C
TOC	28 days from date sampled	One 10-ml bottle	125-ml poly bottle	Add H_2SO_4 until pH <2 and ice to 4°C
TOX	7 days from date sampled	One 200-ml bottle	1-L amber glass bottle	Add H_2SO_4 until pH <2 and ice to 4°C
TRPHs	28 days from date sampled	One 1-L bottle	1-L amber glass bottle	Add H_2SO_4 until pH <2 and ice to 4°C

5.2 Purging

In a nonpumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened interval will mix with the groundwater due to normal flow patterns, but the water above the screened interval will remain isolated and become stagnant. Sampling team members should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface. To safeguard against collecting nonrepresentative stagnant water in a sample, the following guidelines and techniques should be adhered to during well purging and sampling:

- As a general rule, all monitoring wells should be pumped or bailed prior to the collection of the sample. Evacuation of a minimum of one volume of water in the well casing, and preferably three to five volumes, is recommended for a representative sample. In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample collection is not as critical. However, in all cases where the monitoring data are to be used for enforcement actions, evacuation is recommended.

- For wells that can be pumped or bailed dry, the well should be evacuated and allowed to recover prior to sample withdrawal. If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred.

- A nonrepresentative sample can also result from excessive pumping of the monitoring well. Stratification of the leachate concentrations in the groundwater formation may occur or compounds that are heavier than water may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

5.3 Materials

The material used to construct groundwater purging and sampling devices can have a significant impact on the analytical results. If practical, equipment that contacts the groundwater should be constructed from stainless steel, teflon, or glass. The use of plastic should be avoided when analyzing for organics. Table 2 discusses the advantages and disadvantages of groundwater sampling devices, and Table 3 provides a ranking of sample material compatibility under various aqueous environments.

Table 2 Advantages and Disadvantages of Various Groundwater Sampling Devices

Device	Advantages	Disadvantages
Bailer	■ The only practical limitations are size and materials ■ No power source needed ■ Portable ■ Inexpensive; it can be dedicated and hung in a well, reducing the chances of cross-contamination ■ Minimal outgassing of volatile organics while sample is in bailer ■ Readily available ■ Removes stagnant water first ■ Rapid, simple method for removing small volumes of purge water	■ Time consuming, especially for large wells ■ Transfer of sample may cause aeration
Submersible Pump	■ Portable; can be used on an unlimited number of wells ■ Relatively high pumping rate (dependent on depth and size of pump) ■ Generally very reliable; does not require priming	■ Potential for effects on analysis of trace organics ■ Heavy and cumbersome, particularly in deeper wells ■ Expensive ■ Power source needed ■ Susceptible to damage from silt or sediment ■ Impractical in low-yielding or shallow wells
Non-Gas Contact Bladder Pump	■ Maintains integrity of sample ■ Easy to use	■ Difficult to clean, although dedicated tubing and bladder may be used ■ Only useful at depths down to approximately 100 feet ■ Supply of gas for operation (bottled gas and/or compressor) is difficult to obtain and is cumbersome
Suction Pump	■ Portable, inexpensive, and readily available	■ Only useful at depths down to approximately 25 feet ■ Vacuum can cause loss of dissolved gases and volatile organics ■ Pump must be primed and vacuum is often difficult to maintain ■ May cause pH modification
Inertia Pump	■ Portable, inexpensive, and readily available ■ Rapid method for purging relatively shallow wells	■ Only useful at depths down to approximately 70 feet ■ May be time consuming to use ■ Labor-intensive ■ WaTerra pump is only effective in 2-inch diameter wells

Table 3 Relative Compatibility of Rigid Groundwater Sampling Materials

	PVC I	Galvanized Steel	Carbon Steel	Low-carbon Steel	Stainless Steel 304	Stainless Steel 316	Teflon
Buffered Weak Acid	100	56	51	59	97	100	100
Weak Acid	98	59	43	47	96	100	100
Mineral Acid/High Solids	100	48	57	60	80	82	100
Aqueous/Organic Mixtures	64	69	73	73	98	100	100
Percent Overall Rating	91	58	56	59	93	96	100

Preliminary Ranking of Rigid Materials:

Teflon
Stainless Steel 316
Stainless Steel 304
PVC I
Low-Carbon Steel
Galvanized Steel
Carbon Steel

6. Equipment Checklist

6.1 General

- Water level indicator (e.g., electric sounder, steel tape, transducer, reflection sounder, air line, etc.);
- Depth sounder;
- Appropriate keys for well cap locks;
- Steel brush;
- Organic vapor analyzer (OVA) or photo-ionization meter (HNu);
- Oil/water interface indicator (if necessary);
- Timepiece (preferably a stopwatch);
- Logbook;
- Calculator;

- Field data sheets;
- Bottle labels;
- Chain-of-custody forms;
- Custody seals;
- Sample containers;
- Engineer's rule;
- Sharp knife (locking blade);
- Tool box (screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench, bolt cutters, etc.);
- Leather work gloves;
- Appropriate personnel protection equipment;
- 5-gallon pails;
- Plastic sheeting;
- Sealable plastic bags;
- Shipping containers;
- Packing material;
- U.S. Department of Transportation (DOT) shipping labels;
- 55-gallon 1A2 (17-H) drums (if necessary);
- Decontamination solutions;
- Tap water;
- Non-phosphate soap;
- Aluminum foil;
- Garden sprayers;

- Brushes;
- Preservatives; and
- Distilled or deionized water, as necessary.

6.2 Groundwater Sampling Devices

Bailers

- Clean decontaminated bailers of appropriate size and construction material;
- Nylon line (enough to dedicate to each well);
- Sharp knife;
- Aluminum foil (to wrap clean bailers);
- Submersible Pumps
- Pump(s);
- Adequate power supply, generator, or battery;
- 1-inch black poly vinyl chloride (PVC) coil pipe (enough to dedicate to each well);
- Hose clamps;
- Safety cable (i.e., heavy-grade nylon line);
- Tool box supplement (pipe wrenches, wire strippers, electric tape, heat shrink, hose connectors, teflon tape);
- Winch or pulley (if desired);
- Gasoline for generator;
- Flow meter with gate valve; and
- 1-inch nipples and various pipe connectors.

Bladder Pumps

- Non-gas contact bladder pump;

- Compressor or nitrogen gas bottles;
- Batteries and charger;
- Teflon tubing (enough to dedicate to each well);
- Swagelock fitting; and
- Toolbox supplement (same as submersible pump).

Suction Pump

- Pump;
- Black coil pipe tubing (enough to dedicate to each well);
- Gasoline (if required);
- Toolbox supplement (same as submersible pump);
- Various hose connectors and nipples; and
- Flow meter with gate valve.

7. Preparation

7.1 Office Preparation

- The preparation of a Site-Specific Safety Plan (SSSP) is required prior to any sampling. The SSSP must be approved and signed by the Corporate Health and Safety Officer or designee (i.e., the Regional Safety Coordinator [RSC]);
- Prepare a Site-Specific Work Plan (SSWP) to meet the data quality objectives of the project in accordance with contract requirements. Review available background information (e.g., topographic maps, hydrogeologic maps, geologic maps, other site reports, etc.) to determine the extent of the sampling effort, the sampling method to be employed, and the type and amounts of equipment and supplies required;
    - Obtain necessary sampling and monitoring equipment (see Section 6), preclean the sampling equipment, and ensure that it is in proper working order;
    - Ensure that batteries are charged, including the OVA, HNu, pump control box, and large storage batteries;

- Locate local sources for preservatives and decontamination solutions. Review this matter with the RSC or site safety coordinator;

- Contact delivery service to confirm ability to ship all equipment and samples. Determine if shipping restrictions exist; and

- Prepare schedules and coordinate with staff, clients, and regulatory agencies, if appropriate.

7.2 Field Preparation

- Identify local suppliers of expendable sampling equipment such as ice and baggies, and overnight delivery services;

- Inspect all sampling equipment and reclean, if necessary, prior to groundwater sampling (see Table 4);

Table 4 Decontamination Solutions

Type of Hazard	Name of Solution	Remarks
Amphoteric-acids and bases	Sodium bicarbonate	5-15% aqueous solution
Inorganic acids, metal processing wastes, heavy metals	Sodium carbonate	Good water softener, 10-20% aqueous solution
Solvents and organic compounds, oily, greasy unspecified wastes	Trisodium phosphate	Good rinsing solution of detergent, 10% aqueous solution
Pesticides, fungicides, cyanides, ammonia, and other non-acidic inorganic wastes	Calcium hypochlorite	Excellent disinfectant, bleaching and oxidizing agent, 10% aqueous solution
Other Types of Decontamination Solutions		
Other Detergents and Aqueous Surfactants		
Phosphate-free laboratory detergent (Alconox, Liquinox), Pennsalt 91, Oakite, Gunk, Clorox		
Solvents		
1,1,2-Trichloroethane, H2-ethyl-hexyl acetate, pesticide-grade isopropanol/acetone/methanol/hexane, heptane (nonhydrogen bonding), alcohol, diesel fuel, naphtha, beta-propiolactone, carbon tetrachloride, 8% formalinethylene, 8% hexachloromelamine, 1,2-dichloroethane (in solution), Quadcoat		
Other Solutions		
10% nitric acid, 0.1 N/10%/20% hydrochloric acid		
Water		
Potable/tap water (demonstrated to be analyte-free), distilled water, deionized water, reagent-grade distilled and deionized water		

Source: Adapted from Devinny *et al.* 1990; Mickam *et al.* 1989.

- A general site survey should be performed prior to site entry in accordance with the SSSP followed by a site safety meeting; and

- Identify all well locations.

8. Reagents

Except for decontamination solutions and sample preservatives, there are no reagents required for these procedures. Refer to E & E Standard Operating Procedure for *Equipment Decontamination* (ENV 3.15), the SSSP, or the SSWP for proper decontamination procedures and appropriate solvents.

9. Field Sampling Procedures

9.1 Sampling Preparation

- Start at the least-contaminated well, if known;

- Remove locking well cap. Note the location of the well, time of day, and date in the field logbook or sample log;

- Remove the well cap covering the well riser;

- Test the well for volatile organic compounds (VOCs) and methane by conducting a headspace analysis with a combustible gas indicator, an OVA (for VOCs and methane), or an HNu (for VOCs). Record all readings in the field logbook;

- Lower water level measuring device into well until the surface of the water table is encountered;

- Measure the distance from the top of the water table to a reference point on the well riser or casing (e.g., top of inside casing [TOIC]) and record the distance in the field logbook;

- Lower the water level measuring device to the bottom of the well, and measure the total depth of the well using the same reference point on the well riser or casing. Record the distance in the field logbook.

- Measure the diameter of the well, and calculate the volume of water in the well by multiplying the number of feet of water by the number of gallons per foot (see Section 10);

- Determine the required volume of groundwater to be removed from the well (e.g., three well volumes or as indicated in the SSWP);

- Place plastic sheeting on the ground around the well to minimize the likelihood of contamination of sampling equipment from soil adjacent to the well; and

- Prepare the purging and sampling equipment.

9.2 Purging

The amount of flushing that a well receives prior to sample collection depends on the intent of the monitoring program, as well as the hydrogeologic conditions. Programs in which overall quality determinations of water resources are involved may require long pumping periods to obtain a sample that is representative of the groundwater. The pumped volume can be determined prior to sampling, or the well can be pumped until selected parameters (e.g., temperature, electrical conductance, pH, turbidity, etc.) have stabilized. Care must be taken not to exceed the recommended purging rate for monitoring well screens (see Table 5).

Monitoring for defining a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water, but not enough to induce flow from other areas.

During purging, water level measurements may be taken regularly at 15- and 30-second intervals. The data may be used to compute water table or aquifer transmissivity and other hydraulic characteristics.

Information on the most commonly used groundwater purging and sampling devices can be found in E & E's SOP for Groundwater Sampling Devices (ENV 3.6).

9.2.1 Bailers

Equipment needed will include a clean decontaminated bailer, nylon line, a sharp knife, and plastic sheeting. Place the plastic sheeting around the well to prevent contact of the bailer or line with the ground. Attach the line to the bailer, and then lower the bailer until it is completely submerged. Pull the bailer out of the well; ensure that the line either falls onto the plastic sheeting or never touches the ground. Empty the bailer into a 5-gallon pail. Repeat the procedure until the required purge volume has been removed. When the 5-gallon pail is full, pour the water into a 55-gallon drum or handle as indicated in the SSWP.

Table 5 Maximum Recommended Purging Rate for Monitoring Well Screens

Screen Type	Diameter (in)	Slot (in)	Open Area (ft^2/ft)	Open Area (%)	Recommended Pumping Rate gpm/ft at 0.1 ft/s	gpm/ft at 0.07 ft/s	gpm/ft at 0.03 ft/s
PVC (machine slot)	2	0.01	0.018	3.4	0.804	0.563	0.241
	2	0.02	0.033	6.4	1.496	1.047	0.449
	2	0.025	0.042	8.0	1.870	1.309	0.561
	2	0.04	0.060	11.5	2.693	1.885	0.808
	2	0.051	0.075	14.4	3.385	2.369	1.015
	4	0.01	0.036	3.4	1.608	1.126	0.482
	4	0.02	0.067	6.4	2.992	2.094	0.898
	4	0.025	0.083	8.0	3.740	2.618	1.122
	4	0.04	0.120	11.5	5.386	3.770	1.616
	4	0.051	0.151	14.4	6.773	4.741	2.032
PVC (wound)	2	0.01	0.047	9.0	2.119	1.484	0.636
	2	0.02	0.089	17.0	3.989	2.793	1.197
	2	0.03	0.124	23.7	5.579	3.905	1.674
	2	0.04	0.156	29.7	6.981	4.887	2.094
	2	0.05	0.183	34.9	8.197	5.738	2.459
	4	0.01	0.078	7.5	3.522	2.465	1.057
	4	0.02	0.147	14.1	6.607	4.625	1.982
	4	0.03	0.208	19.9	9.350	6.545	2.805
	4	0.04	0.262	25.0	11.750	8.225	3.525
	4	0.05	0.309	29.5	13.869	9.708	4.161
Stainless Steel (wire-wound)	2	0.01	0.090	17.1	4.021	2.814	1.206
	2	0.02	0.157	30.0	7.044	4.931	2.113
	2	0.03	0.210	40.2	9.444	6.610	2.833
	2	0.04	0.253	48.4	11.376	7.963	3.413
	2	0.05	0.287	54.8	12.872	9.010	3.862
	4	0.01	0.177	16.9	7.948	5.563	2.384
	4	0.02	0.307	29.3	13.776	9.643	4.133
	4	0.03	0.410	39.1	18.388	12.872	5.517
	4	0.04	0.492	47.0	22.097	15.468	6.629
	4	0.05	0.560	53.4	25.120	17.584	7.536

9.2.2 Submersible Pumps

- Assemble the pump, hose, and safety cable;
- Lower the pump and assembly into the monitoring well to a point a few feet below the water level;
- Attach to a power source and commence purging operations;
- Using a flow meter or pail and a stopwatch, determine the flow rate and calculate the time required to remove the required volume of water from the well;
- Place the purge water in 55-gallon drums or handle as indicated in the SSWP; and
- Lower the pump by stages until it is just above the screen, and continue to purge until the required volume of water has been removed from the well. In cases where the well will not yield water at a sufficient recharge rate, pump the well dry and allow it to recover.

9.2.3 Non-Gas Contact Bladder Pumps

- Assemble the teflon tubing, pump, and charged control box;
- Procedures for purging with a bladder pump are the same as for a submersible pump (Section 9.2.2); and
- Be sure to adjust the flow rate to prevent violent jolting of the hose.

9.2.4 Suction Pumps

- Assemble the pump, tubing, and power source; and
- Procedures for purging with a suction pump are the same as for a submersible pump (Section 9.2.2).

9.3 Sampling

Groundwater samples can be obtained through the use of a number of groundwater sampling devices. Each groundwater sampling device has its advantages (and disadvantages) over other devices. Ideally, groundwater sampling devices should be completely inert, economical to manufacturer, easily cleaned for reuse, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for both well purging and sample collection. There are several other factors to consider when choosing a groundwater sampling device and care should be taken when selecting the device. Refer to E & E Standard Operating Procedure for Groundwater Sampling Devices (ENV 3.6) for additional information.

9.3.1 Bailers

- Make sure that clean plastic sheeting has been placed around the well;
- Attach a line to the bailer. If a bailer was used for purging, the same bailer and line may be used for sampling;
- Lower the bailer slowly and gently into the well, taking care not to shake the well casing or splash the bailer into the water. Lower the bailer to different points adjacent to the well screen to ensure that a representative water sample is collected;
- Slowly and gently retrieve the bailer from the well, avoiding contact with the well riser;
- Remove the cap from a sample container and place the cap on plastic sheeting or in a location where it will not be contaminated. Refer to Section 9.6 for special considerations for volatile organic analysis (VOA) samples;
- Slowly pour the water into the container;
- Filter and preserve samples as required by the SSWP. Mark the water level on the container with a pen;
- Prepare the necessary QA samples as outlined in the SSWP;
- Record sample information in the field logbook or on field data sheets, and complete the C-O-C form;
- Package samples in accordance with the SSWP; and
- Repeat this process until all groundwater samples have been collected.

9.3.2 Submersible Pumps

- Allow the monitoring well to recharge after purging, keeping the pump just above the screened interval;
- Attach a gate valve to the discharge hose, and reduce the flow rate to a manageable sampling rate;
- Prepare the sample containers;

- If no gate valve is available, discharge the sample into a clean jar and fill the sample containers from the jar;
- Complete the sampling and documentation procedures as outlined in Section 9.3.1; and
- Upon completion, remove the pump and assembly and properly decontaminate the pump prior to use in the next well. Do not reuse the discharge tubing.

9.3.3 Bladder Pump

- Allow the well to recharge after purging;
- Prepare the sample containers;
- Turn the pump on. Increase the cycle time and reduce the pressure to the minimum that will allow groundwater to come to the surface;
- Complete the sampling and documentation procedures as outlined in Section 9.3.1;
- Upon completion, remove the tubing from the well and either replace the teflon tubing and bladder with new dedicated tubing and bladder, or properly decontaminate the existing material;
- Nonfiltered groundwater samples should be collected directly from the outlet tubing into the sample containers; and
- Filtered groundwater samples should be obtained by connecting the pump outlet tubing directly to the filter unit. The pump pressure should be reduced to prevent a pressure buildup on the filter, which could damage the pump bladder.

9.3.4 Suction Pumps

- Allow the well to recharge;
- Attach a gate valve to the discharge line if the suction pump discharge rate cannot be controlled, or discharge the sample into a clean glass jar and fill the sample containers from the jar;
- Sample as outlined in Section 9.3.1; and
- Upon completion, remove the tubing and properly decontaminate the pump prior to use in the next well. Do not reuse the tubing.

9.4 Filtering

Samples being analyzed for total dissolved metals and total organic carbons (TOC) may require filtering. Two types of filters are commonly used: barrel filters and vacuum filters. A barrel filter works with a bicycle pump, which is used to build up positive pressure in the chamber containing the sample. Water is then forced through 0.45-µm filter paper into a jar. The barrel itself is filled manually.

A vacuum filter involves two chambers: the upper chamber contains the sample, and a 0.45-µm filter divides the two chambers. Using a portable vacuum pump, air is withdrawn from the lower chamber, creating a vacuum, which causes the sample to move through the filter into the lower chamber. Repeated pumping may be required to drain all of the sample into the lower chamber. If preservation of the samples is necessary, this should be done after filtering.

9.5 Post-Operation

After all samples have been collected and preserved, the sampling equipment should be properly decontaminated to prevent cross-contamination of samples.

- Decontaminate all equipment according to the SSWP;
- Replace sampling equipment in storage containers;
- Prepare groundwater samples for shipment. Check sample documentation and make sure samples are properly packed for shipment; and
- Organize field notes into a report format and transfer logging information to appropriate forms.

9.6 Special Consideration for VOA Sampling

The proper collection of a sample for dissolved VOCs requires minimal disturbance of the sample to limit volatilization and subsequent loss of volatiles from the sample.

Sample retrieval systems suitable for the valid collection of volatile organic samples include: positive-displacement bladder pumps, gear-driven submersible pumps, and syringe samplers and bailers. Field conditions and other constraints will limit the choice of appropriate systems. The principal objective is to provide a valid sample for analysis that has been subjected to the least amount of turbulence possible.

The following procedures should be followed when collecting VOA samples:

- Open the vial, set the cap in a clean place, and place the proper amount of preservatives (HCl) in the vial;
- Fill the vial to the top until a convex meniscus forms on the top of the vial. Do not overfill the vial;

- Check that the cap has not been contaminated, and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap;

- Invert the vial and tap gently. If an air bubble appears, discard the sample and begin again. It is imperative that no entrapped air remains in the sample vial;

- Place the VOA vial in a cooler, oriented so that it is lying on its side, not straight up; and

- The holding time, under most protocol parameters, for VOAs is 14 days (see Table 1). It is recommended that samples be shipped or delivered to the laboratory daily. Ensure that the samples remain at 4°C, but do not allow them to freeze.

10. Calculations

Table 6 presents the volume of water in different size casings and holes. To determine the volume of water in a well, the calculations are as follows:

$$V = Tr2(0.163)$$

where:

V = Static volume of well in gallons

T = Depth of water in well, measured in feet (determined by subtracting the static water level from the total depth of the well)

r = Inside radius of well casing, measured in inches

0.163 = A constant conversion factor for the conversion of the casing radius from inches to feet and cubic feet to gallons

Table 6 Volume of Water in Casing or Hole

Diameter of Casing or Hole (in)	Gallons per Foot of Depth	Cubic Feet per Foot of Depth	Liter per Meter of Depth	Cubic Meters per Meter of Depth
1	0.041	0.0055	0.509	0.509×10^{-3}
1.5	0.092	0.0123	1.142	1.142×10^{-3}
2	0.163	0.0218	2.024	2.024×10^{-3}
2.5	0.255	0.0341	3.167	3.167×10^{-3}
3	0.367	0.0491	4.558	4.558×10^{-3}
3.5	0.500	0.0668	6.209	6.209×10^{-3}
4	0.653	0.0873	8.110	8.110×10^{-3}
4.5	0.826	0.1104	10.260	10.260×10^{-3}
5	1.020	0.1364	12.670	12.670×10^{-3}
5.5	1.234	0.1650	15.330	15.330×10^{-3}
6	1.469	0.1963	18.240	18.240×10^{-3}
7	2.000	0.2673	24.840	24.840×10^{-3}
8	2.611	0.3491	32.430	32.430×10^{-3}
9	3.305	0.4418	41.040	41.040×10^{-3}
10	4.080	0.5454	50.670	50.670×10^{-3}
11	4.937	0.6600	61.310	61.310×10^{-3}
12	5.875	0.7854	72.960	72.960×10^{-3}
14	8.000	1.0690	99.350	99.350×10^{-3}
16	10.440	1.3960	129.650	129.650×10^{-3}
18	13.220	1.7670	164.180	164.180×10^{-3}
20	16.320	2.1820	202.680	202.680×10^{-3}
22	19.750	2.6400	245.280	245.280×10^{-3}
24	23.500	3.1420	291.850	291.850×10^{-3}
26	27.580	3.6870	342.520	342.520×10^{-3}
28	32.000	4.2760	397.410	397.410×10^{-3}
30	36.720	4.9090	456.020	456.020×10^{-3}
32	41.780	5.5850	518.870	518.870×10^{-3}
34	47.160	6.3050	585.680	585.680×10^{-3}
36	52.880	7.0690	656.720	656.720×10^{-3}

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs = 3.785 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = 12.319×10^{3} cubic meters per meter of depth

11. Quality Assurance/Quality Control

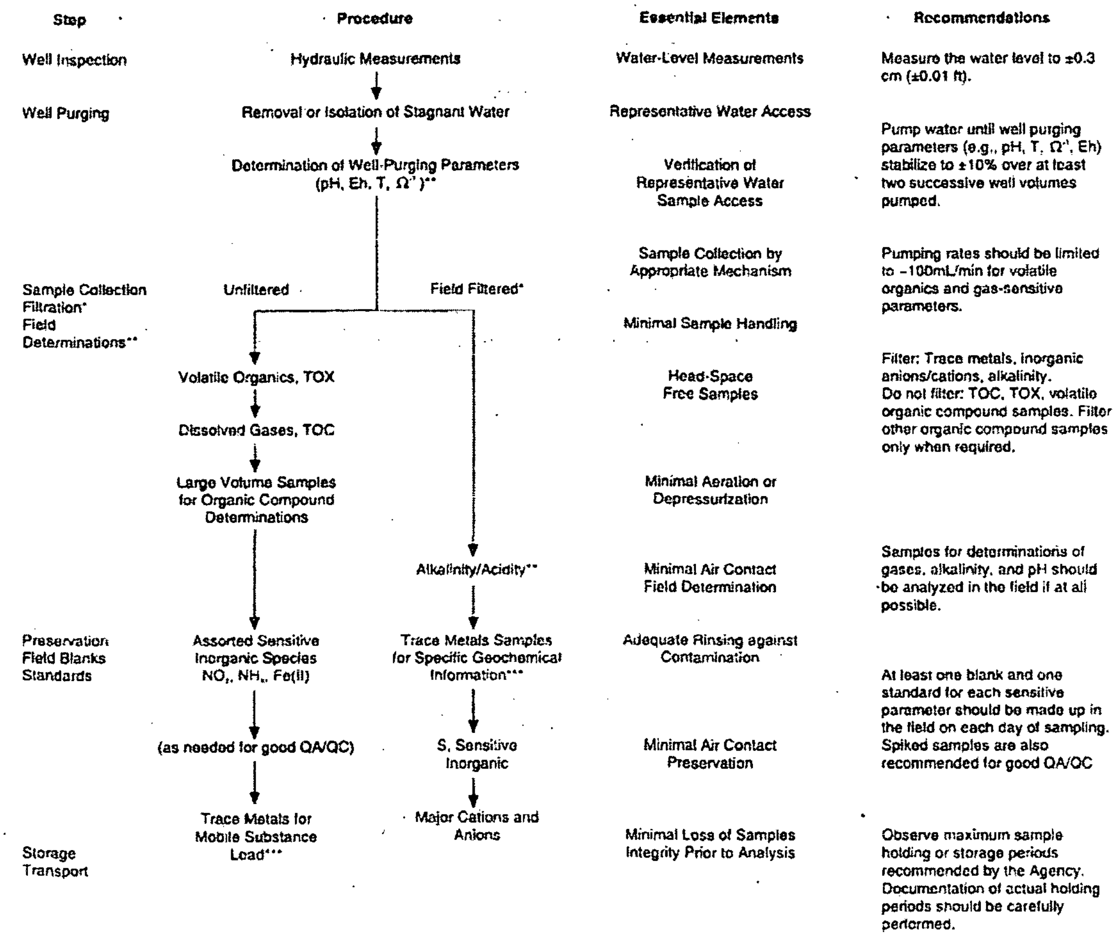
The objective of QA/QC is to identify and implement methodologies that limit the introduction of error into sampling and analytical procedures. Groundwater sampling protocols appropriate to the data quality objectives and site conditions will define the specific procedures that will be followed for sampling events (see Figure 1).

There are seven primary areas of concern for QA in the collection of representative groundwater samples:

- The SSWP should be reviewed by all team personnel involved in the collection of the groundwater samples before any sampling is attempted, with attention to contaminant type and potential concentration variations;
- Log documentation should be reviewed to determine whether the required volume of purge water was removed from the well and that the temperature, electrical conductance, and pH had been stabilized to ensure that a representative water sample of the aquifer was obtained;
- The purging and sampling devices should be made of materials and utilized in a manner that will not interact with or alter the analysis;
- The results generated by these procedures are reproducible as demonstrated through the use of duplicate samples;
- The possibility of cross-contamination is reduced by collecting samples from the least contaminated well first. Rinsate blanks should be incorporated where dedicated sampling and purging equipment is not utilized and decontamination of the equipment between sampling events is required;
- Samples are properly labeled, documented (C-O-C), preserved, and shipped; and
- A record of daily field activities, such as sample collection and tracking information, is kept in a bound book.

12. Data Validation

The data generated will be reviewed according to the QA/QC considerations presented in Section 11.



* Denotes samples that should be filtered to determine dissolved constituents. Filtration should be accomplished preferably with in-line filters and pump pressure or by N_2 pressure methods. Samples for dissolved gases or volatile organics should not be filtered. In instances where well development procedures do not allow for turbidity-free samples and may bias analytical results, split samples should be spiked with standards before filtration. Both spiked samples and regular samples should be analyzed to determine recoveries from both types of handling.

** Denotes analytical determinations that should be made in the field.

See Puls and Barcelona (1989).

Figure 1 Generalized Flow Diagram of Groundwater Sampling Protocol

13. Health and Safety

Depending on the site-specific contaminants, the type of personnel protective equipment (PPE) used during the purging and sampling of the wells is outlined in the SSSP. The SSSP should be reviewed with specific emphasis placed on the safety procedures to be followed for the well sampling tasks. Standard safe operating practices should be followed, such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and protective clothing.

14. References

American Society for Testing and Material (ASTM), 1986, *Standard Guide for Sampling Groundwater Monitoring Wells*, D-4448-85a, Philadelphia, Pennsylvania.

Barcelona, M.J., J.P. Gibb, and R.A. Miller, 1983, *A Guide to the Selection of Materials for Monitoring Well Construction and Groundwater Sampling*, Illinois State Water Survey, Champaign, Illinois.

Barcelona, M.J., J.A. Helfrich, E.E. Garske, and J.P. Gibb, 1984, "A Laboratory Evaluation of Groundwater Sampling Mechanisms," *Groundwater Monitoring Review*, 2:32-41.

Barcelona, M.J., J.A. Helfrich, and E.E. Garske, 1985, "Sampling Tubing Effects on Groundwater Samples," *Analysis Chemistry*, 57:460-463.

Driscoll, F.G., 1986, *Groundwater Wells*, Johnson Division, UOP Inc., St. Paul, Minnesota

Gibb, J.P., R.M. Schuller, and R.A. Griffin, 1980, *Monitoring Well Sampling and Preservation Techniques*, EPA-600/9-80-010.

Keely, J.F., 1987, "Monitoring Well Installation, Purging, and Sampling Techniques - Part I: Conceptualizations," *Groundwater*, 300-313.

Korte, N. and P. Kearl, 1985, *Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells*, Second Edition, U.S. Department of Energy, GJ/TMC-08, Technical Measures Center, Grand Junction Projects Office.

Nielsen, M. and L. Yeates, 1985, "A Comparison of Sampling Mechanisms Available for Small-Diameter Groundwater Monitoring Wells," *Groundwater Monitoring Review*, 2:83-99.

Scalf, M.J., W. Dunlop, R. Crosby, and J. Fryberger, 1980, *Manual for Groundwater Sampling Procedures*, R.S. Kerr Environmental Research Laboratory, Office of Research and Development, Ada, Oklahoma.

Sisk, S.W. 1981, NEIC *Manual for Ground/Surface Investigations at Hazardous Waste Sites*, EPA-330/9-81-002, Washington, D.C.

U.S. Code of Federal Regulations, 49 CFR Parts 100 to 177, Transportation.

U.S. Department of Commerce, 1976, *Handbook for Sampling and Sample Preservation of Water and Wastewater*, NTIS PB-259-946.

U.S. Department of the Interior, *National Handbook of Recommended Methods for Water-Data Acquisition*, Reston, Virginia.

U.S. Environmental Protection Agency, 1977, *Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities.*

__________, 1981, *Manual of Groundwater Quality Sampling Procedures*, EPA-600/2-81-160, Washington, D.C.

__________, 1982, *Methods for Chemical and Sample Preservation of Water and Wastewater*, EPA-600/4-82-029, Washington, D.C.

__________, 1985, *Practical Guide for Groundwater Sampling*, EPA-600/2-85-104, Washington, D.C.

__________, 1993, *Subsurface Characterization and Monitoring Techniques*, EPA-625/R-93/003, Washington, DC.

Title:	GEOLOGIC LOGGING
Category:	GEO 4.8
Revised:	March 1998

STANDARD OPERATING PROCEDURE

GEOLOGIC LOGGING

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TITLE:	GEOLOGIC LOGGING		
CATEGORY:	GEO 4.8	REVISED:	March 1998

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Introduction

Geologic logging involves keeping detailed records during the drilling of boreholes, the installation of monitoring wells, and the excavation of test pits, and entering the geologic descriptions of the soil and rock samples recovered on a standardized form. E & E has adapted a standardized geotechnical logbook (see DOC 2.4 in E & E's Standard Operating Procedures [SOPs]) that contains items deemed important to record when installing monitoring wells, piezometers, and/or soil borings. This document discusses general procedures for completing geologic logs.

2. Drilling Logs

2.1 Basic Documentation

When drilling boreholes, the project geologist should maintain a log that describes each borehole. The E & E Geotechnical Logbook contains records for boreholes. The following basic information should be entered on the heading of each drilling log sheet (see Figure 1):

- Borehole/well number;
- Project name;
- Site location;
- Dates and times that drilling was started and completed;
- Drilling company;
- E & E geologist's name;
- Drill rig type used to drill the borehole;
- Drilling method(s) used to drill the borehole;

TITLE:	GEOLOGIC LOGGING		
CATEGORY:	GEO 4.8	REVISED:	March 1998

DRILLING LOG FOR ____________

Project Name ____________

Site Location ____________

____

Date Started/Finished ____________

Drilling Company ____________

Driller's Name ____________

Geologist's Name ____________

Geologist's Signature ____________

Rig Type(s) ____________

Drilling Method(s) ____________

Bit Size(s) ________ Auger Size(s) ________

Auger/Split Spoon Refusal ____________

Total Depth of Borehole is ____________

Total Depth of Corehole is ____________

Water Level (TOIC)		
Date	Time	Level (Feet)

Well Location Sketch

Depth (Feet)	Sample Number	Blows on Sampler	Soil Components CL SI S GR	Rock Pile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											

Figure 1 Drilling Log

- Bit and auger size(s);
- Depth of auger/split barrel sampler refusal;
- Total depth of borehole;
- Total depth of corehole (if applicable);
- Water level at time of completion measured from top of inside casing (TOIC); and
- A well location sketch.

2.2 Technical Information

During the drilling of a borehole, specific technical information about the unconsolidated material and rock encountered should be recorded on the drilling log sheet. The following minimum technical information should be recorded:

- Depth that sample was collected or encountered;
- Sample number assigned (if applicable);
- The number of blow counts required to drive the split barrel sampler 2 feet at 6-inch intervals (see Table 1);
- Description of soil components (see Figure 2);
- Description of rock profile (see Figure 3);
- Rock qualitative designation (RQD) (see Figure 4);
- Rock penetration time;
- Core run number (if applicable) and percent recovery; and
- Organic vapor readings in the sample.

Table 1 Standard Penetration Test for Soil Density

N-Blows/Feet	Relative Density
Cohesionless Soils	
0 - 4	Very loose
4 - 10	Loose
10 - 30	Medium
30 - 50	Dense
50	Very dense
Cohesive Soils	
2	Very soft
2 - 4	Soft
4 - 8	Medium
8 - 15	Stiff
15 - 30	Very stiff
30	Hard

3. Soil Classification

Soils should be described using the Unified Soil Classification System (USCS) in the narrative lithologic description section of Figure 5. Figure 6 is a summary of the American Society for Testing and Materials (ASTM) criteria for describing soils. Soil descriptions should be concise, stressing major constituents and characteristics, and should be given in a consistent order and format. The following order is recommended by the ASTM:

1. Soil name. The basic name of the predominant constituent and a single-word modifier indicating the major subordinate constituent.

2. Gradation or Plasticity. Granular soils (i.e., sands or gravels) should be described as well-graded, poorly-graded, uniform, or gap-graded, depending on the gradation of the minus 3-inch fraction. Cohesive soils (i.e., silts and clays) should be described as nonplastic, slightly plastic, moderately plastic, or highly plastic, depending on results of the manual evaluation for plasticity.

3. Particle size distribution. An estimate of the percentage and grain-size range of each subordinate constituent of the soil. This description may also include a description of angularity (see Figure 7).

4. Color. The basic color of the soil.

SOIL AND SEDIMENT CLASSIFICATION

GRAIN-SIZE SCALE (Modified Wentworth Scale)

phi	mm	Inches	U.S. Standard Sieve Series	Grade Name		
-12	4096	161.30				
				very large		
-11	2048	80.60				
				large		
-10	1024	40.30			Boulders	
				medium		
-9	512	20.20				
				small		
-8	256	10.10				
				large		
-7	128	5.00			Cobbles	
				small		GRAVEL
-6	64	2.52	63.0 mm			
				very coarse		
-5	32	1.26	31.5 mm			
				coarse		
-4	16	0.63	16.0 mm			
				medium	Pebbles	
-3	8	0.32	8.0 mm			
				fine		
-2	4	0.16	No. 5			
				very fine		
-1	2	0.08	No. 10			
				very coarse		
0	1	0.04	No. 18			
				coarse	Sand	SAND
+1	0.500		No. 35			
				medium		
+2	0.250		No. 60			
				fine		
+3	0.125		No. 120			
				very fine		
+4	0.062		No. 230			
				coarse		
+5	0.031				Silt	
				medium		
+6	0.016					
				fine		
+7	0.008					MUD
				very fine		
+8	0.004					
				coarse		
+9	0.002					
				medium		
+10	0.001					
				fine		
+11	0.0005					
				very fine		CLAY SIZE
+12	0.00025					

PROPORTIONS USED IN DESCRIBING SOILS

Trace - Particles are present but estimated to be less than 5%
Few - 5 to 10%
Little - 15 to 25%
Some - 30 to 45%
Mostly - 50 to 100%

I.e.: Sand with a trace of silt = 95% Sand, < 5% Silt

(When sampling gravelly soils with a standard split spoon, the true percentage of gravel is often not recovered due to relatively small sample diameter.)

Soil Density from Standard Penetration Test (ASTM D1586)	
Granular Soils	Cohesive Soils
0 - 10. Loose	0 - 4: Soft
10 - 30 Medium Dense	4 - 8: Medium Stiff
30 - 50 Dense	8 - 15. Stiff
Over 50 Very Dense	15 - 30. Very Stiff

CLASSIFICATION CHART (United Soil Classification System)

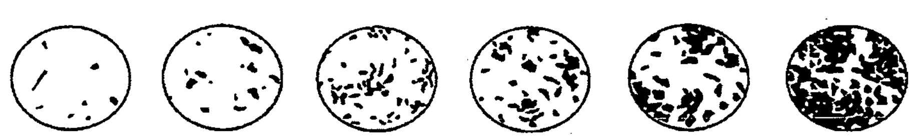
MAJOR DIVISIONS		Symbols	TYPICAL NAMES
Coarse Grained Soils (More than 1/2 of soil > no 200 sieve size)	GRAVELS (More than 1/2 of coarse fraction > No. 4 sieve size)	GW	Well-graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel-sand mixtures little or no fines
		GM	Silty gravels, gravel-sand-silt mixture
		CC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than 1/2 of coarse fraction < No. 4 sieve size)	SW	Well-graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand clay mixtures
Fine Grained Soils (More than 1/2 of soil < no 200 sieve size)	SILTS AND CLAYS LL< 50	ML	Inorganic silts, and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays, of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic clays of low plasticity
	SILTS AND CLAYS LL> 50	MH	Inorganic silts, micaceous or diatomaceous, fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils

Figure 2 USCS Soil Classification Chart

ROCK DESCRIPTIVE TERMS

Term		Defining Characteristics	
Hardness	Soft	Scratched by fingernail	
	Moderately Hard	Scratched easily by penknife	
	Hard	Difficult to scratch with a penknife	
	Very Hard	Cannot be scratched by penknife	
Weathering	Unweathered	Rock is unstained. May be fractured, but discontinuities are not stained.	
	Slighty	Rock is unstained. Discontinuities show some staining on the surfaces of rocks, but discoloration does not penetrate rock mass.	
	Moderate	Discontinuity surfaces are stained. Discoloration may extend into rock along discontinuity surfaces.	
	High	Individual rock fragments are thoroughly stained and may be crumbly.	
	Severe	Rock appears to consist of gravel-sized fragments in a "soil" matrix. Individual fragments are thoroughly discolored and can be broken with fingers.	
Bedding Planes	Laminated	< .04 in.	< 1 mm
	Parting	.04 in. - .24 in.	1mm - 6mm
	Banded	.24 in. - 1in.	6 mm - 3 cm
	Thin	1 in. - 4 in.	3 cm - 9.1 cm
	Medium	4 in. - 12 in.	9.1 cm - 30.5 cm
	Thick	12 in.- 36 in.	30.5 cm - 1m
	Massive	> 36 in.	> 1 m
Joints and Fracture Spacing	Very tight	< 2 in.	< 5.1 cm
	Tight	2 in. - 1ft.	5.1 - 30.5 cm
	Moderately tight	1ft. - 3 ft.	30.5 cm - 91.4 cm
	Wide	3 ft. - 10 ft.	91.4 cm - 3 M
	Very wide	> 10 ft.	> 3 M
Voids	Porous	Smaller than a pinhead. Their presence is indicated by the degree of absorbency.	
	Pitted	Pinhead size to a 1/4 inch. If only thin walls separate the individual pits, the core may be described as honeycombed.	
	Vug	1/4 inch to the diameter of the core. The upper limit will vary with core size.	
	Cavity	Larger than the diameter of the core.	

Rock Particle Percent Composition Estimation



1% 5% 10% 15% 25% 50%

Figure 3 Rock Descriptive Terms

ROCK QUALITY DESIGNATION (RQD) AND FRACTURE FREQUENCY

Core borings are a useful means of obtaining information about the quality of rock mass. The recoverable core indicates the character of the intact rock and the number and character of the natural discontinuities.

Another quantitative index that has proved useful in logging NX core is a rock quality designation (RQD) developed by Deere (1963). The RQD is a modified core recovery percentage in which all the pieces of *sound NX core over 4 inches long are counted as recovery.* The length of the core run is the distance to the nearest tenth of a foot from the corrected depth of the hole at the end of the previous run to the *corrected depth of the hole at the end of subject run.* The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. The RQD is a more *general measure of the core quality* than the fracture frequency. Core loss, weathered and soft zones, as well as fractures, are accounted for in this determination. The RQD provides a preliminary estimate of the variation of the in situ rock mass properties from the properties of the "sound" portion of the rock core. Thus, a general estimate of the behavior of the rock mass can be made. An RQD approaching 100 percent denotes an excellent quality rock mass with properties similar to that of an intact specimen. RQD values ranging from 0 to 50 percent are indicative of a poor quality rock mass having a small fraction of the strength and stiffness measured for an intact specimen.

RQD (Rock Quality Designation)

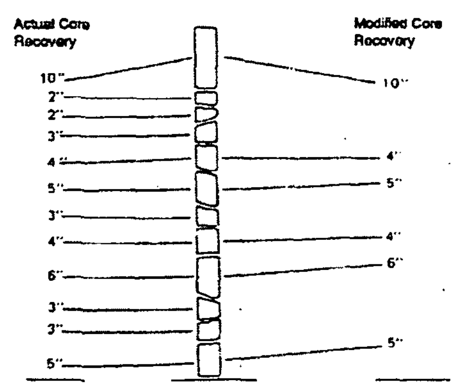
0 - 25 Very Poor
25 - 50 Poor
50 - 75 Fair
75 - 90 Good
90 - 100 Excellent

An example of determining the RQD from a core run of 60 inches measured from corrected depth to corrected depth is given in Diagram 1. For this particular case, the core recovery was 50 inches and the modified core recovery was 34 inches. This yields an RQD of 57 percent, classifying the rock mass in the fair category.

Problems arise in the use of RQD for determining the in situ rock *mass quality. The RQD evaluates fractures in the core caused by* the drilling process, as well as in natural fractures previously existing in the rock mass. For example, when the core hole *penetrates a fault zone or a joint, additional breaks may form that,* although not natural fractures, are caused by natural planes of weakness existing in the rock mass. These fresh breaks occur during drilling and handling of the core and are not related to the quality of the rock mass. The skill of the driller will affect the amount of breakage and the core loss that occurs. Poor drilling techniques will "penalize" the rock by lowering its apparent quality. It is difficult to distinguish between drilling breaks and those natural and incipient fractures that reflect the quality of the rock mass. In certain instances, it may be advisable to include all fractures when estimating RQD. Obviously, some judgement is involved in core logging.

Another problem with the use of the RQD index is that the determinations are not sensitive to the tightness of the individual joints, whereas in some instances, the in situ deformation modulus may be strongly affected by the average joint opening.

RQD OF A SINGLE CORE RUN *

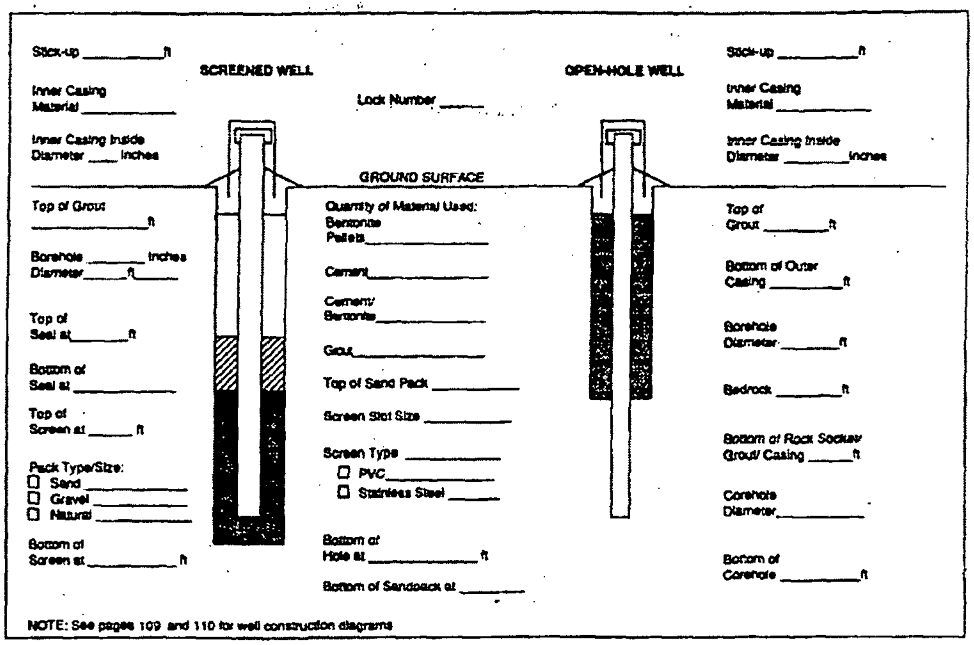


Core Run 60"
(Corrected depth to corrected depth)

$\frac{34"}{60"} \times 100\% = 57\% = \text{Fair}$

* Typical calculation of RQD of a single core run. Note that the run is calculated from corrected depth to corrected depth.

Figure 4 Rock Qualitative Designation (RQD)



Depth-ft.	NARRATIVE LITHOLOGIC DESCRIPTION	Moisture Content Dry	Moist	Wet
		○	○	○
1		○	○	○
2		○	○	○
3		○	○	○
4		○	○	○
5		○	○	○
6		○	○	○
7		○	○	○
8		○	○	○
9		○	○	○
10		○	○	○
11		○	○	○
12		○	○	○
13				
14		○	○	○
		○	○	○

Figure 5 Narrative Lithologic Description

ASTM CRITERIA FOR DESCRIBING SOIL

Criteria for Describing Angularity of Coarse-Grained Particles

Description	Criteria
Angular	Particles have sharp edges and relatively plane side with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved side and no edges

Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and shard surface

Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varing material or color with layers at least 6 mm thick; note thickness.
Laminated	Alternating layers of varying materials or color with the layers less than 6 mm thick; note thickness.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness.
Homogeneous	Same color and appearance throughout.

Figure 6 ASTM Criteria For Describing Soil

CRITERIA FOR DESCRIBING SOIL (Cont.)

Criteria for Describing the Reaction with HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

Criteria for Describing Consistency

Description	Criteria
Very Soft	Thumb will penetrate soil more than 1 inch (25 mm)
Soft	Thumb will penetrate soil about 1 inch (25 mm)
Firm	Thumb will indent soil about 1/4 inch (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Criteria for Describing Particle Shape

The particle shape shall be described as follows where length, width, and thickness refer to greatest, intermediate, and least dimensions of a particle, respectively (see page 104).

Flat	Particles with width/thickness ratio > 3
Elongated	Particles with length/width ratio > 3
Flat and Elongated	Particles meet criteria for both flat and elongated

Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A 1/8 inch (3 mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

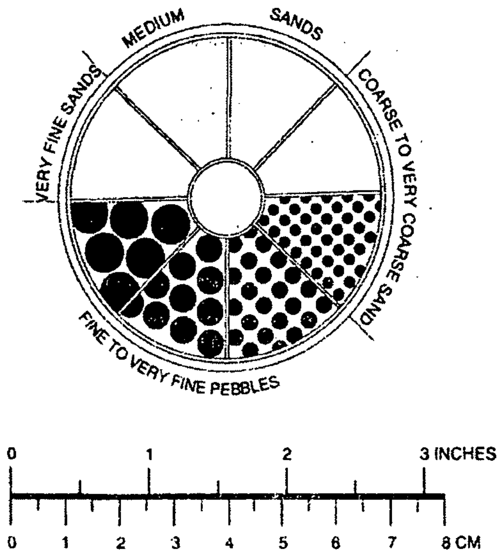
Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

Figure 6 ASTM Criteria for Describing Soil (cont.)

SEDIMENT PARTICLE SIZE AND SHAPE ESTIMATES

GRAPH FOR DETERMINING SIZE OF SEDIMENTARY PARTICLES



COBBLES RANGE FROM 6.4 TO 25.6 cm (~2.5 TO 10.1 INCHES)
BOULDERS ARE LARGER THAN 25.6 cm (>10.1 INCHES)

SEDIMENT PARTICLE SHAPES

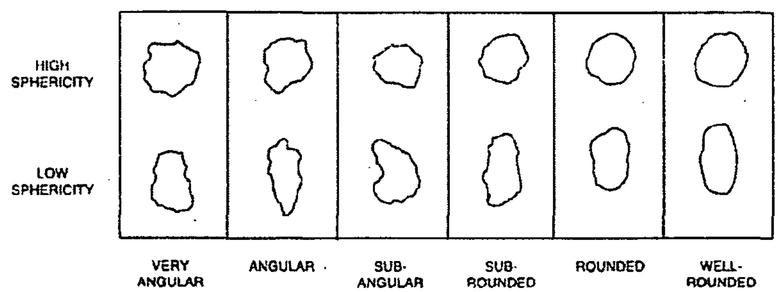


Figure 7 Sediment Particle Size and Shape Estimates

5. Moisture content. The amount of soil moisture (dry, moist, or wet).

6. Relative density or consistency. An estimate of density of a granular soil or consistency of a cohesive soil, usually based on the standard penetration test results (see Table 1).

7. Soil Structure or Mineralogy. Description of discontinuities, inclusions, and structures. Includes joints, fissures, and slickensides.

4. Core Logging

4.1 Handling of Core

After the core has been recovered from the corehole and the core barrel has been opened, the core should be placed in a core box. The top of the core should be placed at the back left corner of the core box, and the remaining core placed to the right of the preceding section (see Figure 8). The core box should be filled in this manner, moving to the front sections of the core box. The beginning of each run should be marked on the core and also noted with a marked wooden block.

4.2 Rock Description

Each stratigraphic unit in the core shall be logged. A line marking the depth of the top and the bottom of the unit shall be drawn horizontally. In classifying the rock, the geologist should avoid being too technical, as the information presented must be used by numerous people with widely divergent backgrounds.

The classification and description of each unit should be given in the following order, as applicable:

1. Unit designation (Miami oolite, Clayton Formation, Chattanooga shale);

2. Rock type;

3. Hardness;

4. Degree of weathering;

5. Texture;

6. Structure;

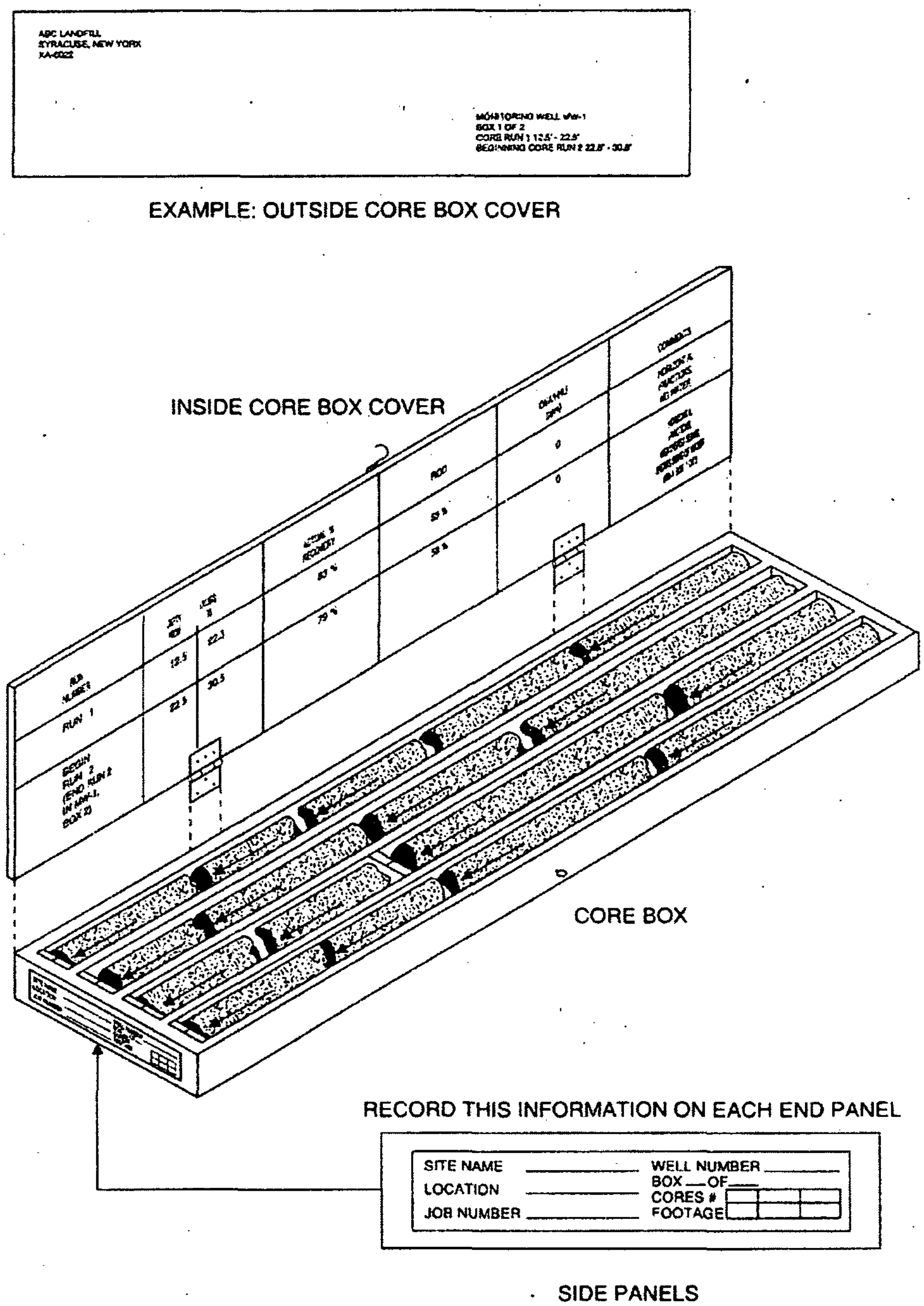


Figure 8 Core Box

7. Color;

8. Solution and void conditions;

9. Swelling properties;

10. Slaking properties; and

11. Additional description, such as mineralization, size, and spacing shale seams, etc.

Variations from the general description of the unit and features not included in the general description shall be indicated by brackets and lines to show the depth and the interval in the core where the feature exists. These variations and features shall be identified by terms that will adequately describe the feature or variation so as to delineate it from the unit. These may be zones or seams of different color, texture, etc., from that of the unit as a whole, such as staining; variations in texture; shale seams, gypsum seams, chert nodules, calcite masses, etc.; mineralized zones; vuggy zones, joints, fractures; open and/or stained bedding planes; faults, shear zones, gouge; cavities' thickness, open or filled, nature of filling, etc.; or any core left in the bottom of the hole after the final pull.

Rock Type and Lithology

1. Rock will be classified according to the following 24 types:

   - Sandstone
   - Conglomerate
   - Coal
   - Compaction Shale
   - Cemented Shale
   - Indurated Clay
   - Limestone
   - Chalk
   - Gneiss
   - Schist

- Graywacke
- Quartzite
- Dolomite
- Marble
- Soapstone and Serpentine
- Slate
- Granite
- Diorite
- Gabbro
- Rhyolite
- Andesite
- Basalt
- Tuff or Tuff Breccia
- Agglomerate or Flow Breccia

2. Lithologic characteristics should be included to differentiate rocks of the same classification. These adjectives should be simple and easily understood, such as shaly, sandy, dolomitic, etc. Inclusions, nodules, and concretions should also be noted here.

3. It is important to maintain a simple but accurate rock classification. The rock type and lithologic characteristics are essentially used to differentiate the rock units encountered.

Hardness

The terms for hardness, as outlined below, were modified to include the use of a rock hammer.

1. **Very soft** or plastic - can be deformed by hand (has a rock-like character but can be broken easily by hand).

2. **Soft** - can be scratched with a fingernail (cannot be crumbled between fingers but can be easily pitted with light blows of a geology hammer).

3. **Moderately hard** - can be scratched easily with a knife; cannot be scratched with a fingernail (can be pitted with moderate blows of a geology hammer).

4. **Hard** - difficult to scratch with a knife (cannot be pitted with a geology hammer but can be chipped with moderate blows of the hammer).

5. **Very hard** - cannot be scratched with a knife (chips can be broken off only with heavy blows of the geology hammer).

Weathering

The degree and depth of weathering is very important and should be accurately detailed in the general description and clearly indicated on the drill log.

1. **Unweathered** - no evidence of any mechanical or chemical alteration.

2. **Slightly weathered** - superficial discoloration, alteration, and/or discoloration along discontinuities; less than 10% of the rock volume is altered; strength is essentially unaffected.

3. **Moderately weathered** - discoloration is evident; surface is pitted and altered, with alterations penetrating well below rock surfaces; 10% to 50% of the rock is altered; strength is noticeably less than unweathered rock.

4. **Highly weathered** - entire section is discolored; alteration is greater than 50%; some areas of slightly weathered rock are present; some minerals are leached away; retains only a fraction of its original strength (wet strength is usually lower than dry strength).

5. **Decomposed** - saprolite; rock is essentially reduced to a soil with a relic rock texture; can be molded or crumbled by hand.

Texture

Texture is used to denote the size of the grains or crystals comprising the rock, as opposed to the arrangement of the grains or crystals, which is considered a structure.

1. **Aphanitic** - grain diameter less than 0.004 inch (0.1 mm); individual grains or crystals are too small to be seen with the naked eye.

2. **Fine-grained, finely crystalline** - grain diameter between 0.004 inch (0.1 mm) and 0.003 (1 mm); grains or crystals can be seen with the naked eye.

3. **Medium-grained, crystalline** - grain diameters between 0.003 foot (1 mm) and 0.0175 foot (5 mm).

4. **Coarse-grained, coarsely crystalline** - grain diameter greater than 0.0175 foot (5 mm).

Structure

The structural character of the rock shall be described in terms of grain or crystal alignment, bedding, and discontinuities, as applicable. The terms may be used singularly or paired.

1. **Foliation and/or lineation** - give approximate dip uniformity, degree of distinctiveness, banding, etc.

2. **Joints:**
   a. Type - bedding, cleavage, foliation, extension, etc.
   b. Degree of openness - tight or open.
   c. Surface or joint plane characteristics - smooth, rough, undulating.
   d. Weathering - degree, staining.
   e. Frequency - see (4).

3. **Fractures, shears, gouge:**
   a. Nature - single plane or zone. (Note thickness.)
   b. Character of materials in plane or zone.
   c. Slickensides.

4. **Frequency:**
   a. Intact - spacing greater than 6 feet (2 m).
   b. Slightly jointed (fractured) - spacing 3 feet (1 m) to 6 feet (2 m).
   c. Moderately jointed (fractured) - spacing 1 foot (0.3 m) to 3 feet (1 m).
   d. Highly jointed (fractured) - spacing 0.3 foot (9.1 cm) to 1 foot (0.3 m).
   e. Intensely jointed (fractured) - spacing less than 0.3 foot (9.1 cm).

5. **Bedding** is used to describe the average thickness of the individual beds within recognized unit, and the terms thick, medium, or thin should not be applied to the individual beds. "Parting" and "band" are used to describe single stratum as outlined below:
   a. Massive - over 3 feet thick (1 m).
   b. Thick - 1 foot (30.5 cm) to 3 feet (1 m) thick.
   c. Medium - 0.3 foot (9.1 cm) to 1 foot (30.5 cm) thick.
   d. Thin - 0.1 foot (3.0 cm) to 0.3 foot (9.1 cm) thick.

e. Band - 0.02 foot (6 mm) to 0.1 foot (3.0 cm) thick, described to the nearest 0.01 foot.
f. Parting - less than 0.02 foot (6 mm).
g. Paper-thin parting.

The terms and descriptions for the structure of the rock are to be used to describe the character of the rock units recognized and are not to be used as a substitute for describing individual discontinuities. Except for areas where the rock is intensely fractured or jointed, each discontinuity should be described on the log as to position, dip, staining, weathering, breccia, gouge, etc.

Color is often valuable in correlating or differentiating samples, but can be misleading or uninformative. The color of a sample should represent the sample in terms of basic hues (i.e., red, blue, gray, black), supplemented with modifying hues as required (i.e., bluish gray, mottled brown). The core should be surface wet when describing the color; if it is dry, the log should indicate "dry color." Subjective colors, such as buff or maroon, should not be used. Specific color charts, such as the Mumsel Color Chart or the Color Index in the Colorado School of Mines, Quarterly, Volume 50, No. 1, are useful in describing color of samples. When such a chart or index is used, it should be noted on the log in the remarks column.

Solution and Void Conditions shall be described in detail, as these features can affect the strength of the rock and can indicate potential seepage paths through the rock. When cavities are detected by drill action, the depth to top and bottom of the cavity should be determined by measuring the stick-up of the drill tools when the cavity is first encountered and again at the bottom, as it is very difficult to reconstruct cavities from the core alone. Filling material, when present and recovered, should be described in detail opposite the cavity. When no material is recovered from the area of the cavity, the inspector should note the probable conditions of the cavity as determined from observing the drilling action and the color of the drill fluid. If the drill action indicated material was present (i.e., slow rod drop, no loss of drill water, noticeable change in color of water return), it should be noted on the log that the cavity was probably filled and the materials should be described as best as possible from the cuttings or traces left on the core. If drill action indicates the cavity was open (i.e., no resistance to the drill tools, loss of drill fluid), this should be noted on the drill log. Partially filled cavities should also be noted. All of these observations require close observation of the drill action and water return by both the inspector and the driller; accurate measurement of stick-ups; and detailed inspection of the core. When possible, filling material should be wrapped in foil if left in the core box. If the material is to be tested or examined in the lab, it should be sealed in a jar with proper labels and a spacer, with a note showing the disposition of the material should be placed in the core box at the point from which the material was taken. Terms to describe voids encountered shall be as follows:

1. **Porous** - voids less than 0.003 foot (1 mm) in diameter.
2. **Pitted** - voids 0.03 foot (1 mm) to 0.02 foot (6 mm) in diameter.
3. **Vug** - voids 0.02 foot (6 mm) to the diameter of the core.
4. **Cavity** - voids greater than diameter of the core.

4.3 Core Labeling

The top of the core should be shown on each piece of core with an arrow written in a black, waterproof marker. The arrow will indicate which end of the core is nearer the ground surface. Other core markings may include locations of mechanical breaks and drilling footages.

4.4 Core Box Labeling

Each core box should be labeled as follows:

- On the top left corner of the outer core box, the project name, site location (city and state), and project number should be written.
- On the lower right corner of the outer core box, the corehole number (e.g., MW1, BH2), core box number (e.g., 1 of 2, 2 of 2), and the interval of the core run contained in the core box should be written.
- The side panels should be marked as indicated in Figure 8.
- The inside of the core box cover should be marked as indicated in Figure 8.

4.5 Core Storage

It is important to use proper-sized (HQ or NQ) wooden core boxes for rock core storage. After labeling the box and before closing the box for final storage or shipment, wooden spacers should be inserted into each compartment that contains rock core. This will prevent lateral movement of the cores, which could damage the rock material during handling.

After properly logging, labelling, and packing the cores, the core boxes should be stored in a dry location, preferably off of the floor on a pallet. The boxes can be stacked to a reasonable height so as not to be unstable, with end labelling facing out.

5. References

American Society for Testing and Materials (ASTM), 1975, Test Method for Classification of Soils for Engineering Purposes, ASTM D2487-69, Philadelphia, Pennsylvania.

__________, 1975, Recommended Practice of Description of Soils, ASTM D2488-69, Philadelphia, Pennsylvania.

Deere, D.V., 1963, Technical Description of Rock Cores for Engineering Purposes: Rock Mechanics and Engineering Geology, Vol. 1, No. 1, pp. 16-22.

Dow Chemical, 1980, Field Data Handbook, Dowell Division of Dow Chemical Company, Houston, Texas.

Driscoll, J.T., R.V. Dietrich, and R.M. Foose, 1989, AGI Data Sheets for Geology in the Field, Laboratory, and Office, Third Edition, American Geological Institute, Alexandria, Virginia.

U.S. Army Corps of Engineers, St. Louis District, Inspector's Manual, St. Louis, Missouri.

U.S. Environmental Protection Agency (EPA), 1986, RCRA Groundwater Monitoring Technical Enforcement Guidance Document, Washington, D.C.

Title:	GEOPROBE OPERATION
Category:	GEO 4.12
Revised:	March 1998

STANDARD OPERATING PROCEDURE

GEOPROBE OPERATION

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TITLE:	GEOPROBE OPERATION		
CATEGORY:	GEO 4.12	**REVISED:**	March 1998

TABLE OF CONTENTS

Section Page

LIST OF FIGURES

Figure | Page

1. Introduction

1.1 Scope

This document provides basic information on the operation and application of the Geoprobe Model 8-A hydraulic sampler for subsurface investigations. E & E uses the Geoprobe for hazardous waste site investigations. In addition, field procedures and limitations of the Geoprobe are discussed. This document is meant to be used in conjunction with other E & E standard operating procedures for field operations and incorporates all of the safety precautions that should be followed when planning a Geoprobe subsurface investigation.

1.2 Objectives

Geoprobes can collect one-time subsurface samples to determine the presence and/or extent of contaminants in soil gas, groundwater, and soils with a minimum disturbance of the ground surface. The Geoprobe Model 8-A is a hydraulically powered, van-mounted subsurface sampling device capable of collecting subsurface soil gas samples, subsurface soil samples, and groundwater samples. The information obtained from the Geoprobe investigation can be used to define the extent of contamination in the area and assist in determining the placement of monitoring wells.

1.3 Method Selection Considerations

The Geoprobe provides a means of rapidly assessing the presence of contaminants in near-surface unconsolidated soils. The Geoprobe 8-A can penetrate much farther in dry, loose soil than in tightly bound clay and is not recommended for use in rocky soils or tightly compacted glacial till deposits. Other subsurface investigation methods should be considered for sampling in consolidated deposits. Use of the Geoprobe 8-A in these situations may result either in damage to the Geoprobe or injury to the operator.

2. Description

The Geoprobe 8-A is a hydraulically powered probing device. The unit consists of a powered percussion hammer that is slide-mounted on a derrick and has a 3.5-foot stroke. The derrick assembly hydraulically folds and unfolds from the traveling or storage position in the rear compartment of the van. The derrick is also adjustable in both the fore and aft directions, as well as angle, to ensure the derrick is vertical. There are no side-to-side adjustments on E & E's commercial Geoprobes.

The Geoprobe 8-A uses the weight of the van and a hydraulically powered percussion hammer to advance 3-foot-long rods into the ground. The probe rods are hardened steel with an inside diameter (ID) of 0.5 inch and an outside diameter (OD) of 1 inch. The operator controls the hydraulic hammer through the use of levers, and the helper assists by adding sections of rod. Depending on the purpose of the investigation, the lead rod will be equipped to collect soil, groundwater, or soil gas samples. After the lead rod has been driven into the ground 2.5 feet, the helper attaches an additional 3-foot-long section of rod and the process is repeated until the desired depth has been reached.

3. Responsibilities

3.1 Operator

The crew consists of an operator and a helper. The operator is responsible for the safe and efficient operation of the Geoprobe, and also performs the daily inspections and maintenance. In addition, the operator inventories the supplies and equipment daily and ensures that an adequate supply of expendable parts are on hand.

The operator is responsible for completing the subsurface investigation in accordance with the site-specific work plan and in a safe manner consistent with the site health and safety plan. Routinely, the operator is also the field team leader and as such, is responsible for (1) the quality of the samples recovered from the Geoprobe; (2) compliance with the project's quality assurance/quality control requirements; and (3) completion of the site log.

If the operator observes any unsafe or potentially dangerous situations, the operator will stop operations until the proper corrective actions have been taken. The operator has the authority to secure operations at any location if the operator concludes that the conditions are dangerous or could compromise the quality of the samples.

3.2 Helper

The primary function of the helper is to assist the operator in conducting the subsurface investigation. The helper is responsible for assembling, securing, and disassembling the rods and other sampling tools used in the investigation. The helper is also responsible for ensuring that all of the equipment is properly decontaminated and that all tools are in proper working order.

If the helper notices any unsafe or potentially dangerous situations, the helper will inform the operator immediately. The helper must be attentive to conditions around the Geoprobe because the operator will be concentrating on the operation of the unit.

3.3 Site Safety Coordinator

The site safety coordinator (SSC) is responsible for ensuring that the subsurface investigation is completed as outlined in the site health and safety plan. The SSC will ensure that all overhead and buried utilities (e.g., electrical lines, telephone lines, natural gas lines) have been identified and located prior to commencing the subsurface investigation. The SSC will be familiar with the operations of the Geoprobe and the potential hazards posed by its operation. In many cases, the operator or helper also serves as the SSC.

4. Planning the Geoprobe Survey

In planning the Geoprobe survey, research should be conducted on local and regional geology and hydrogeologic conditions; historic records on the size of the site; past waste disposal practices; types of waste material disposed of at the site; and depth and orientation of waste material. Sites should be evaluated in terms of their hydrogeologic setting. This evaluation will indicate the effectiveness of the survey, given site conditions.

4.1 Researching the Site

Prior to designing the field survey, the following information should be collected, if available, from reconnaissance surveys, interviews, and research reviews:

- Information on the types and locations of materials that may be buried on site to determine where subsurface investigations should not be conducted with a Geoprobe, and to identify the type(s) of samples to be collected;

- Information on the surface layout of the site being studied, including information on topography, site boundaries, and the locations of buildings, rail lines, overhead and buried utility lines (e.g., electric lines, pipelines, etc.), scrap disposal areas, and other structures that may prevent the proper operation of the Geoprobe; and

- Maps, drawings, and photographs of the area; historical aerial photographs may indicate previous disposal areas and poor waste disposal practices, and can also provide a base map for plotting data.

4.2 Defining and Mapping the Survey Site

After obtaining background data, the proposed sampling locations should be laid out based on the locations of buried material. Safety and accessibility are other factors to consider when locating sampling locations.

5. Field Procedures

5.1 Overhead and Buried Utilities

The use of a Geoprobe on a site or project near electrical power lines and other utilities requires that special precautions be taken by both the operator and the helper. Electricity can shock, burn, and cause death. By law, overhead and buried utilities must be located, noted, and emphasized on all subsurface investigation location plans and assessment sheets. When overhead electrical power lines exist at or near the site, consider all wires to be live and dangerous. Watch for sagging power lines before entering the site. Do not lift power lines to gain entrance; call the power company and ask them to raise the lines or de-energize the lines. Before raising the derrick near power lines, walk completely around the unit. Determine what the minimum distance from any point on the unit to the nearest power line will be when the derrick is being raised. Do not raise the derrick or operate the unit if this distance is less than 25 feet or, if known, the minimum clearance stipulated by federal, state, and local regulations. To avoid contact with power lines, never move the Geoprobe with the derrick in a raised position.

If there are any questions concerning the safety of drilling on sites near overhead power lines, contact the power company. The power company will provide expert advice at the site as a public service at no cost.

Underground electrical utilities are as dangerous as overhead power lines. Be aware and always suspect the existence of underground utilities. If a sign warning of underground utilities is located on a site boundary, do not assume that underground utilities are located on or near the boundary or property line under the sign. Always contact the owners of utilities and determine jointly the precise location of underground utility lines, and mark or flag the locations. Besides electrical, other utilities that need to be checked are gas, telephone, water, cable TV, fiber optics (very important because of the cost to repair them), and sewer. Potentially responsible parties (PRPs) are often uncooperative in this regard. Private locators can be contracted to survey areas that the utility locators will not.

5.2 Operating the Geoprobe

5.2.1 Visual Inspection

At the start of each work day, the operator must visually inspect the Geoprobe. This includes (1) checking the hydraulic fluid levels and the hydraulic lines for fraying, cuts, or leaks; (2) checking the derrick and attachments assembly for adequate lubrication and for damage, nicks, burrs, and leaks; (3) removing any unnecessary dust, dirt, or oil to prevent jams or damage to the equipment; (4) checking nuts and bolts; and (5) checking the sampling equipment (e.g., drive rods, anvils, and pull caps). Figures 1 and 2 show the inspection points on the Geoprobe 8-A.

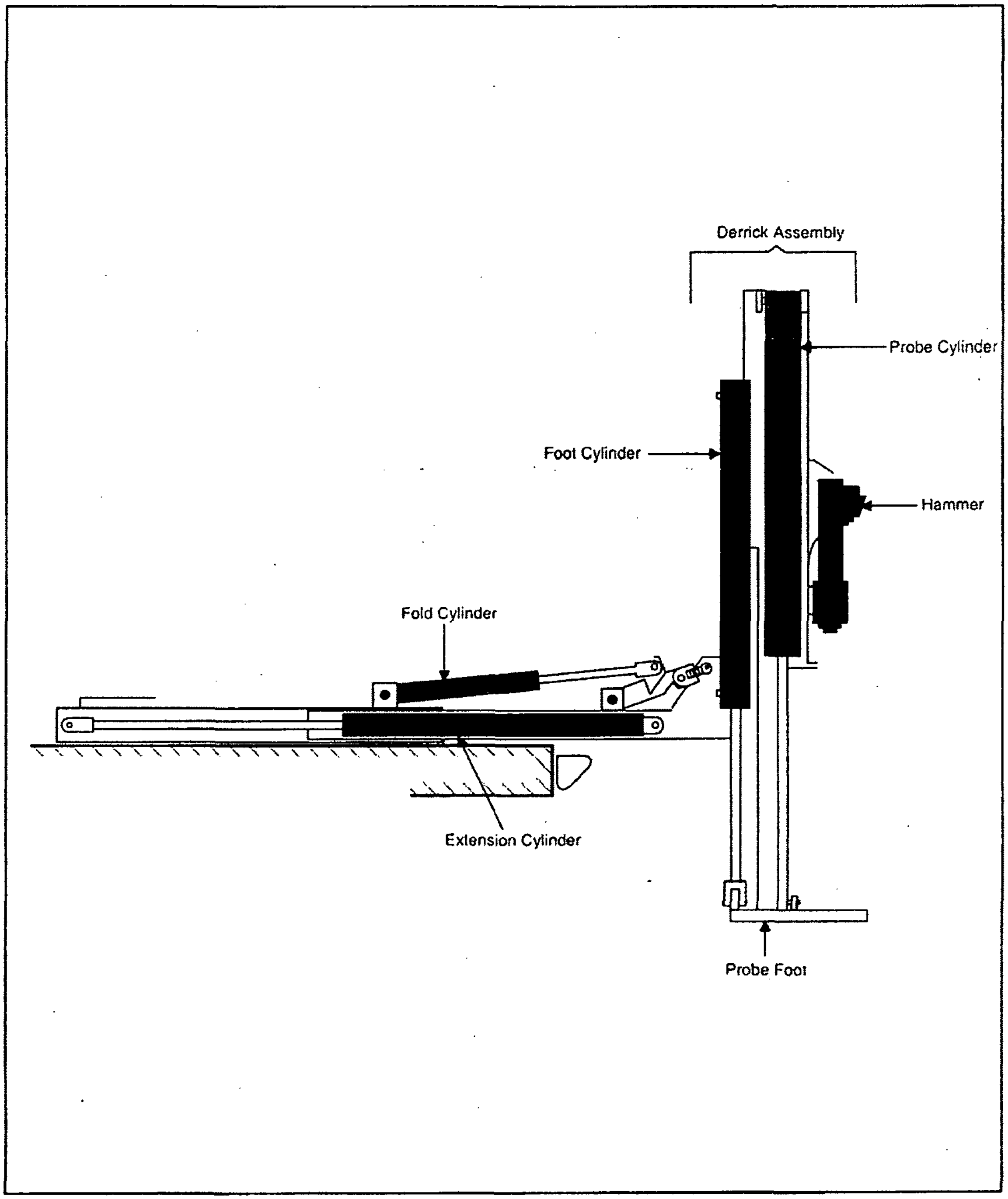


Figure 1 Side View of Inspection Points on the Hydraulic Unit

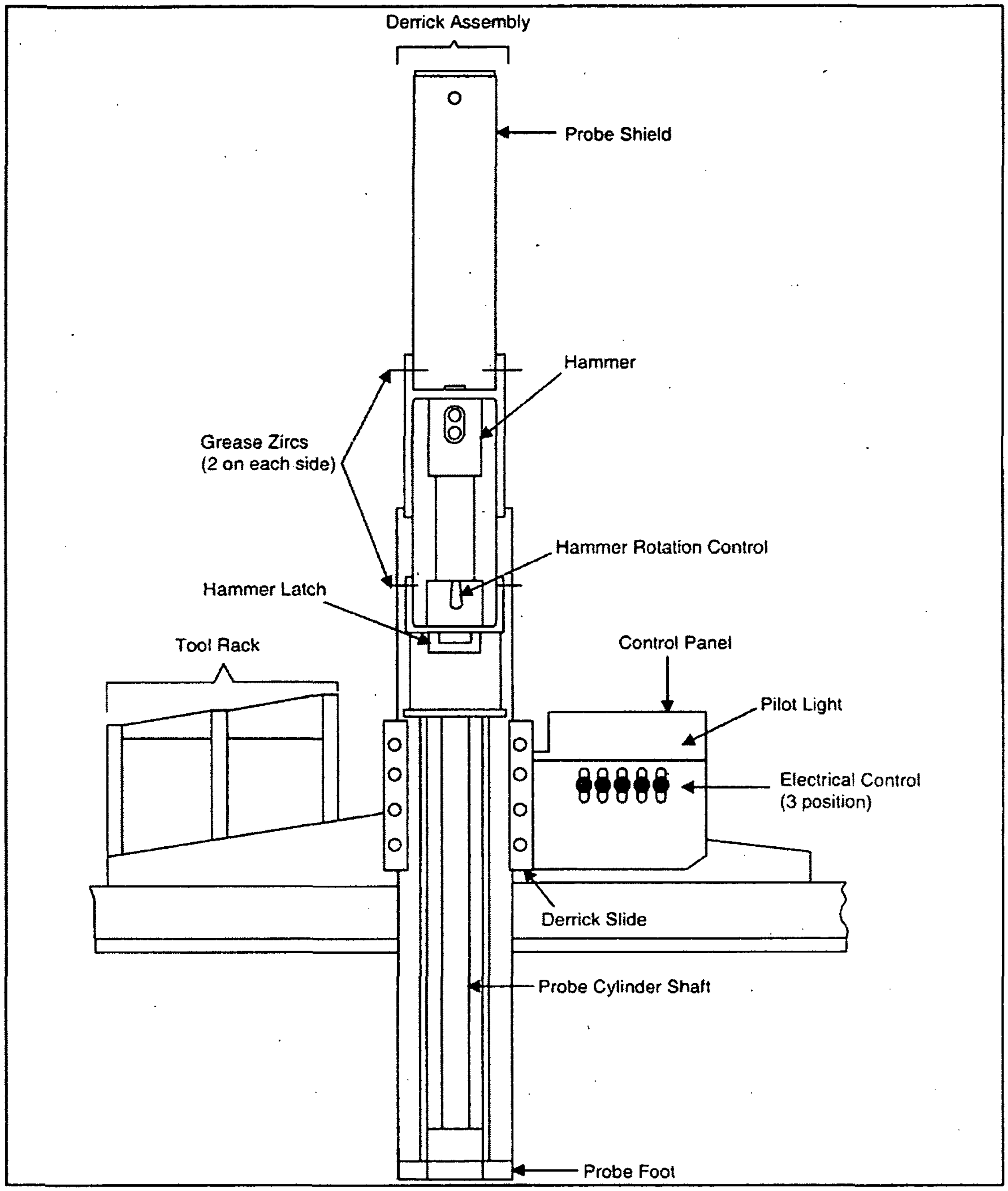


Figure 2 Front View of Inspection Points on the Hydraulic Unit

5.2.2 Setup of the Geoprobe

Following the visual inspection and routine maintenance of the Geoprobe, the unit is ready for operation. The following steps describe the setup procedures for the Geoprobe 8-A:

- Position the vehicle at the sampling location. Park the van as level as possible; the van must be level in the side-to-side aspect to drive the rods properly. If on an incline, point the front of the van upgradient. If possible, face the van downwind to avoid potential cross-contamination from the vehicle's exhaust and to prevent exhaust fumes from entering the work area.

- Set the parking brake and position the chock blocks in front of the front wheels.

- Open and secure the rear doors in the open position with the bungee cords provided so that wind or vibrations will not cause the doors to swing into the work area during operation.

- Attach the exhaust hose to the tailpipe and direct the exhaust downwind from the work area.

- Start the vehicle engine with the remote ignition switch located on the side panel inside the rear of the vehicle. Switch the cooling fan to the "on" position (switch in side panel). Set the toggle switch on the Geoprobe 8-A control panel to the middle (slow) position to activate the hydraulic system clutch. See Figure 3 for a diagram of the control panel.

- Push the FOLD lever down to raise the derrick assembly from its resting position to clear the hydraulic hoses. The derrick assembly should be raised no more than 1 foot because of the clearance restrictions of the rear doors.

- Push the EXTEND lever down to move the derrick assembly backward out of the vehicle. Watch the clearance of the derrick at the top of the door opening. Extend the derrick to the full back position so that the top of the derrick will clear the van doors when raising the derrick.

- Push the FOLD lever down again to raise the derrick to a vertical position.

- Lift the EXTEND lever to bring the derrick assembly back close to the vehicle to lessen the strain on the derrick mount assembly. Proper position is approximately 1 foot behind the rear bumper.

- Push down on the FOOT lever until the foot contacts the ground.

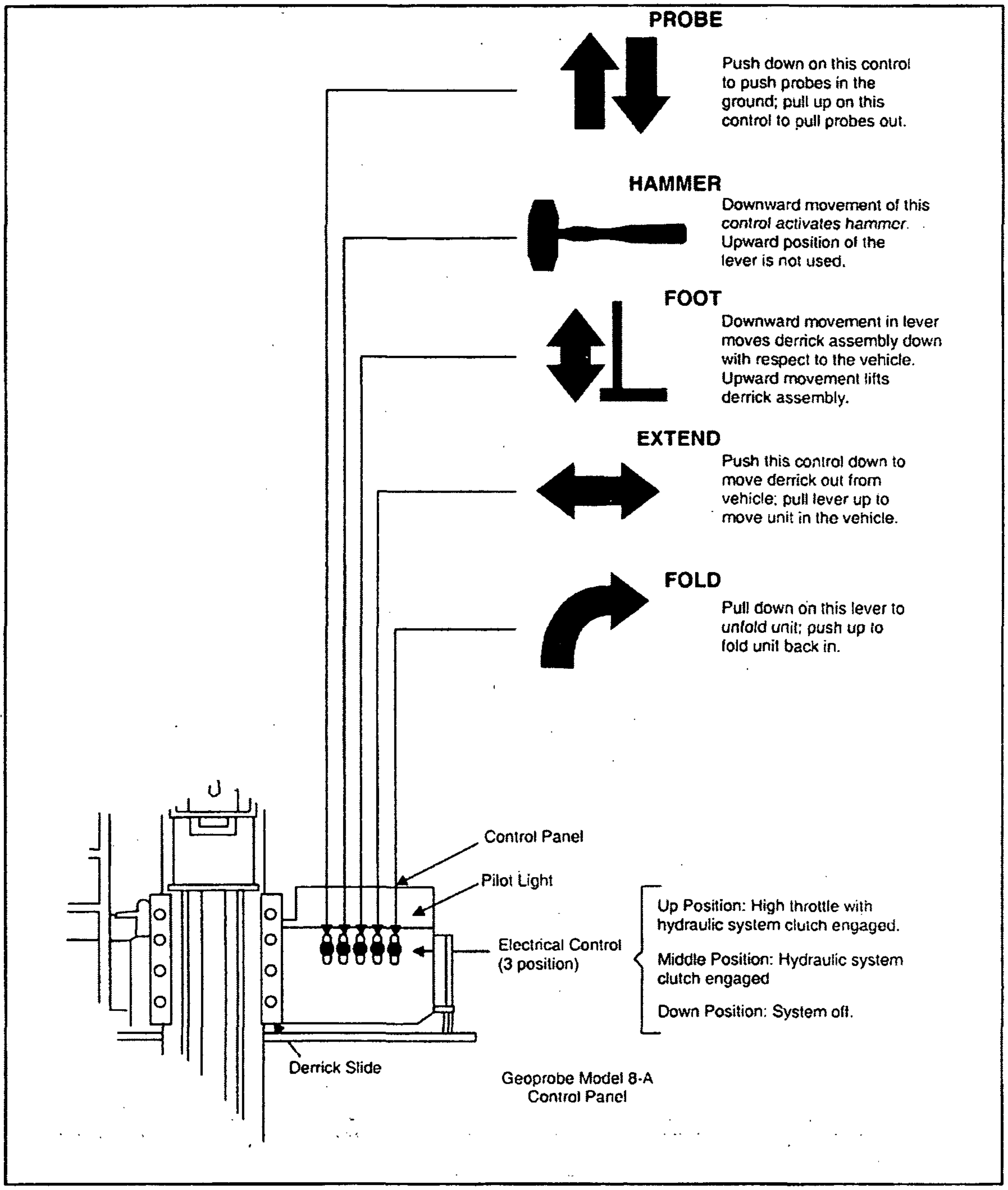


Figure 3 Geoprobe Model 8-A Control Panel

- Adjust the derrick until it is vertical, using the lever provided to check for true vertical.

- Adjust the foot by pushing down on the FOOT lever and raising the rear bumper of the van approximately 1 foot. Do not raise the rear wheels off of the ground.

- Lift up on the PROBE lever and raise the derrick to its maximum height. Check that the derrick is true vertical and adjust as necessary.

- Shut off the hydraulics by switching the toggle switch on the control panel fully down, and secure the anvil in its cradle with the hammer latch. Never work on or in the hammer while the hydraulics are engaged.

- Assemble the desired lead rod and sampling assembly and attach a drive cap to the top of the lead rod.

- Place the toggle switch up to the slow position, and place the lead rod below the hammer assembly. The lead rod should be centered and parallel with the derrick. Push down on the PROBE lever while ensuring that the drive cap is seated in the anvil.

The Geoprobe 8-A is now ready to advance the sampler into the ground.

5.2.3 Rod Advancement

To advance the lead rod to the project depth, the following procedures should be followed when using the Geoprobe 8-A:

- With the toggle switch in the center (slow) position, the operator continues to hold the PROBE lever down. The lead rod will need to be steadied with the operator's hand until the anvil is in contact with the lead rod. Only the operator, who is handling the controls, should steady the rod or reach near the hammer assembly. The lead rod will be pushed slowly into the ground. This procedure allows the operator to gauge the soil resistance and avoid deflection.

- At the point where the lead rod does not advance and the weight of the van is placed on the rod, move the toggle switch to the full up (fast) position. Push down again on the PROBE lever and continue to push the lead rod. Allow the rear of the van to rise 6 inches off of the ground. When the weight of the van is insufficient to push the rod into the ground, push the HAMMER lever down. When the rod has advanced to the point where the derrick foot is again on the ground, release the HAMMER lever, and push the PROBE lever down until the van rises 6 inches. Repeat this process until the rod is fully driven into the ground.

- Raise the hammer anvil to its full height by lifting the PROBE lever, and turn the toggle switch to the off position. Never reach into or around the hammer anvil while the toggle switch is in the on position. The helper then removes the drive cap from the lead rod and attaches the drive cap to the next rod to be used. The helper then attaches the next 3-foot rod section to the rod that has just been driven.

- The toggle switch is raised to the fast position, and Steps 2 and 3 are repeated until the desired depth is reached. If the rods do not advance, do not attempt to force them.

The Geoprobe 8-A is now ready for the crew to perform the required sampling activities.

5.2.4 Rod Removal

After completion of the required sampling activities, the rods may be extracted from the ground by lifting the PROBE lever and raising the hammer assembly. Put the toggle switch in the off position, and lift the hammer latch to remove the anvil. Leave the hammer latch open. Once the helper has attached the pulling cap to the rod, the operator will position the toggle switch to the middle (slow) position and push the PROBE lever down and lower the hammer assembly down to the pulling cap. The operator will turn the toggle switch off and will close the hammer latch under the pulling cap. The operator will place the toggle switch in the slow position and lift the PROBE lever up to raise the hammer assembly fully up. (NOTE: The rods should never be pulled out in the fast position, as this increases the chances of breaking the hammer latch.) The operator will then push the PROBE lever down and lower the hammer assembly sufficiently to clear the pulling cap. The toggle switch is then placed in the slow position, and the PROBE lever is lifted to raise the hammer assembly fully up. The toggle switch is then placed in the off position, and the helper removes the exposed rod and attaches the pulling cap to the next rod section. The sequence is repeated until all rod sections are removed from the ground.

5.2.5 Shutdown

After the rods have been extracted from the ground, the Geoprobe 8-A is ready to be shut down and moved to the next sampling location. The following procedures should be followed when securing the Geoprobe 8-A:

- Place the toggle switch in the middle (slow) position, push the PROBE lever down, and lower the hammer assembly to the bottom of the derrick.

- Lift the FOOT lever to raise the foot completely.

- Push the EXTEND lever down to fully extend the derrick.

- Check to make sure that all hydraulic and electrical lines are clear of the derrick storage area.

- Lift the FOLD lever to fold the derrick assembly to the horizontal position.
- Lift the EXTEND lever to bring the derrick assembly forward into the van.
- Move the toggle switch to the off position to shut off the hydraulics.
- Turn off the cooling fan on the switch in the rear of the van, and shut off the engine using the remote ignition switch on the same panel.
- Remove the exhaust hose from the tailpipe, and remove the chock blocks. Close the doors to complete the shutdown.

The Geoprobe 8-A is now ready to be moved to the next location.

6. Subsurface Soil Sampling

The Geoprobe 8-A is capable of collecting discrete subsurface soil samples with a special soil sampling probe that is screwed onto the end of the lead rod. The sampler consists of the sample tube, cutting shoe, piston tip and piston rod, drive head, and a piston stop pin. A 2-foot-long acetate liner fits inside the sample tube, allowing the collection of a 2-foot-long soil sample. The following steps describe the procedures to follow when collecting soil samples:

- Assemble a clean, decontaminated soil sampler. Attach the drive head to the sample tube. Insert the acetate liner with the lip toward the cutting shoe end. Insert the piston tip and piston rod into the sample tube by feeding the piston rod through the hole in the drive head and attach the cutting shoe to the bottom of the sample tube. Ensure that the piston tip is allowed to slide downward until it is seated in the cutting shoe. Tighten the piston stop pin to complete the assembly. Note that the piston stop pin has a left-handed thread. The piston stop pin must be tight, or vibrations may cause the soil sampler to open at the wrong depth.
- Attach the 1-foot-long adapter rod, and use this assembly as the lead rod.
- Drive rods in a normal manner to the depth from where the sample is to be collected.
- When the specified sample depth is reached, raise the hammer assembly to the top of the derrick and remove the drive cap.
- Three-foot-long, threaded, 0.25-inch-diameter extension rods are used to loosen the piston stop pin. Insert the extension rods into the open drive rods, and attach each rod with a 0.25-inch-ID coupling nut. Connect as many rods as necessary to reach the piston stop pin. Attach an extension rod handle to the top of the last extension rod.

Turn the extension rod handle in a clockwise direction two to three revolutions. Attempt to lift the threaded rods; the rods cannot be lifted if they have started into the piston stop pin. Continue turning the extension rod handle clockwise until the threaded rods have been completely seated into the piston stop pin; the piston stop pin is now ready to be removed. Remove the threaded extension rods one at a time until all have been removed from the drive rods. The last threaded extension rod should have the piston stop pin attached.

- Reattach the drive cap and lower the hammer assembly.
- Advance the drive rods 2 feet.
- Extract all drive rods and remove the soil sampler.
- Repeat these steps as necessary to collect additional subsurface soil samples.

7. Groundwater Sampling

The Geoprobe 8-A is capable of collecting groundwater samples with tygon bailers or a peristaltic pump. The tygon bailers are 3/8-inch OD, which can be inserted into the drive rods. A check valve in the leading end of the bailer may be used to pump the groundwater sample from the rods, or, if soil conditions permit, the drive rods can be extracted and a 0.75-inch-OD bailer can be used in the open hole. If a peristaltic pump is used, tygon tubing is lowered down the rods into the groundwater to collect the groundwater sample. The tubing is then placed into the peristaltic pump, and the groundwater is pumped to the surface. The following steps describe the procedures to follow when collecting groundwater samples.

- The lead rod is assembled using the 2-foot slotted rod, a 1-foot adapter, and an expendable tip.
- The rods are driven in the normal manner until the slotted rod section is beneath the groundwater table.
- The drive cap is removed from the drive rod, and the pulling cap is attached.
- The rods are lifted about 1 foot, which allows the expendable tip to separate from the lead rod. Groundwater will enter the drive rod, and a groundwater sample can now be collected through the rods.
- Extract the drive rods in a normal manner.

8. Soil-Gas Sampling

The Geoprobe 8-A is capable of collecting discrete soil-gas samples using the post-run tubing (PRT) system, which is screwed into the end of the lead rod. The PRT system consists of a PRT expendable point holder with threads for a PRT adapter, a PRT adapter, an expendable point, and disposable tubing. The following steps describe the procedures to follow when collecting soil-gas samples with the Geoprobe.

- Assemble a clean, decontaminated PRT expendable point holder to a clean, decontaminated lead rod.
- Place a rubber "O" ring on a clean, decontaminated expendable drive point, then place the drive point into the PRT expendable point holder.
- Drive rods in a normal manner to the depth from where the sample is to be collected.
- When the specified sample depth is reached, remove the drive cap and attach the pull cap. Pull the rod up approximately 1 foot. This will release the drive point and expose the open end of the PRT expendable point holder. Remove the pull cap to expose the open end of the rod.
- Attach a clean, decontaminated PRT adapter with a rubber "O" ring to the end of the tubing and then insert the tubing and the PRT adapter down the inside of the rods until the PRT comes into contact with the PRT expendable point holder.
- Cut the tubing at the surface so that there is plenty of tubing to connect to the vacuum source. Turn the tubing until the PRT adapter screws securely into the PRT point holder.
- The soil-gas sample is now extracted from the soil and into a container using a vacuum. The container (glass bulb or Tedlar bag) is placed in-line between the vacuum pump and the tubing emerging from the drive rods. The sample is then collected using a vacuum. The vacuum is generated by the on-board vacuum volume pump. This pump will allow the operator to determine the volume of vapor extracted from the soil.
- Once the soil-gas sample is collected, extract all drive rods and the PRT expendable point holder. The expendable point will remain in the ground.
- Repeat these steps as necessary to collect additional subsurface soil-gas samples.

9. Abandonment of Probe Holes

Before probe holes can be abandoned, regulations from the state in which the soil boring and well abandonment will be performed should be consulted. Each state may have specific regulations for soil boring and well abandonment, and these regulations can dictate the method and material that will be used to plug the probe holes. However, in most cases, the state will require that the probe holes be backfilled with some sort of bentonite clay (granular or a slurry).

10. References

Bergren, C.L., R.C. Tuckfield, and N.M. Park, 1990, "Suitability of the Hydropunch for Assessing Groundwater Contamination by Volatile Organics," proceedings of the Fourth National Outdoor Action Conference for Aquifer Restoration, Groundwater Monitoring and Geophysical Methods, National Water Well Association, Dublin, Ohio.

Cordry, K.E, 1986, "Groundwater Sampling Without Wells," proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Groundwater Monitoring, National Water Well Association, Dublin, Ohio.

Ehreuzeller, J.L., F.G. Baker, and V.E. Keys, 1991, "Using the Geoprobe and Hydropunch Method to Collect Reconnaissance Groundwater Samples," *Groundwater Management*, 5:733 (5 NOAC).

Strutymsky, A.I., and T.J. Sainey, 1992, "Use of Geoprobe Penetration Testing and Penetrometry Groundwater Sampling for Volatile Organic Contaminant Plume Detection," ASTM STP 1118, American Society for Testing and Materials, Philadelphia, Pennsylvania.

Title:	SAMPLING EQUIPMENT DECONTAMINATION
Category:	ENV 3.15
Revised:	March 1999

STANDARD OPERATING PROCEDURE

SAMPLING EQUIPMENT DECONTAMINATION

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TITLE:	SAMPLING EQUIPMENT DECONTAMINATION		
CATEGORY:	ENV 3.15	REVISED:	March 1999

TABLE OF CONTENTS

LIST OF TABLES

1. Scope and Application

The purpose of this procedure is to provide a description of methods for preventing or reducing cross-contamination and general guidelines for designing and selecting decontamination procedures for use at potential hazardous waste sites. The decontamination procedures chosen will prevent introduction and cross-contamination of suspected contaminants in environmental samples, and will protect the health and safety of site personnel.

2. Method Summary

Removing or neutralizing contaminants that have accumulated on personnel and equipment ensures protection of personnel from permeating substances, reduces/eliminates transfer of contaminants to clean areas, prevents the mixing of incompatible substances, and minimizes the likelihood of sample contamination.

Cross-contamination can be removed by physical decontamination procedures. The abrasive and non-abrasive methods include the use of brushes, high pressure water, air and wet blasting, and high pressure Freon cleaning. These methods should be followed by a wash/rinse process using appropriate cleaning solutions. A general protocol for cleaning with solutions is as follows:

1. Physical removal.
2. Non-phosphate detergent plus tap water.
3. Tap water.
4. 10% nitric acid.
5. Distilled/deionized water rinse.
6. Solvent rinse.
7. Total air dry.
8. Triple rinse with distilled/deionized water.

This procedure can be expanded to include additional or alternate solvent rinses that will remove specified target compounds if required by site-specific work plans (WP) or as directed by a particular client.

3. Interferences

The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte-free distilled/deionized water. Distilled water available from local grocery stores and pharmacies is generally not acceptable for final decontamination rinses. Contaminant-free deionized water is available from commercial vendors and may be shipped directly to the site or your hotel.

The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal water treatment system.

4. Equipment/Apparatus

The following are standard materials and equipment used as a part of the decontamination process:

- Appropriate protective clothing;
- Air purifying respirator (APR);
- Field log book;
- Non-phosphate detergent;
- Selected high purity, contaminant-free solvents;
- Long-handled brushes;
- Drop cloths (plastic sheeting);
- Trash containers;
- Paper towels;
- Galvanized tubs or equivalent (e.g., baby pools);
- Tap water;
- Contaminant-free distilled/deionized water;
- Metal/plastic container for storage and disposal of contaminated wash solutions;
- Pressurized sprayers, H_2O;
- Pressurized sprayers, solvents;
- Trash bags;
- Aluminum foil;
- Sample containers;

- Safety glasses or splash shield; and
- Emergency eyewash bottle.

5. Reagents

There are no reagents used in this procedure aside from decontamination solutions used for the equipment. The type of decontamination solution to be used shall depend upon the type and degree of contamination present and as specified in the project/site-specific Quality Assurance Project Plan (QAPP).

In general, the following solvents are utilized for decontamination purposes:

- 10% nitric acid wash (reagent grade nitric acid diluted with deionized/distilled water – 1 part acid to 10 parts water)[a];
- Acetone (pesticide grade)[b] ;
- Hexane (pesticide grade)[b];
- Methanol; and
- Methylene chloride[b].

[a] Only if sample is to be analyzed for trace metals.
[b] Only if sample is to be analyzed for organics requiring specific or specialized decontamination procedures. These solvents must be kept away from samples in order to avoid contamination by decon solvents.

6. Procedures

Decontamination is the process of removing or neutralizing contaminants that have accumulated on both personnel and equipment. Specific procedures in each case are designed accordingly and may be identified in either the Health and Safety Plan (HSP), WP, QAPP, or all three.

As part of the HSP, a personnel decontamination plan should be developed and set up before any personnel or equipment enters the areas of potential contamination. Decontamination procedures for equipment will be specified in the WP and the associated QAPP. These plans should include:

- Number and layout of decontamination stations;
- Decontamination equipment needed (see Section 4);

- Appropriate decontamination methods;
- Procedures to prevent contamination of clean areas;
- Methods and procedures to minimize worker contact with contaminants during removal of protective clothing;
- Methods and procedures to prevent cross-contamination of samples and maintain sample integrity and sample custody; and
- Methods for disposal of contaminated clothing, equipment, and solutions.

Revisions to these plans may be necessary for health and safety when the types of protective clothing, site conditions, or on-site hazards are reassessed based on new information.

Prevention of Contamination

Several procedures can be established to minimize contact with waste and the potential for contamination. For example:

- Employing work practices that minimize contact with hazardous substances (e.g., avoid areas of obvious contamination, avoid touching potentially hazardous substances);
- Use of remote sampling, handling, and container-opening techniques;
- Covering monitoring and sampling equipment with plastic or other protective material;
- Use of disposable outer garments and disposable sampling equipment with proper containment of these disposable items;
- Use of disposable towels to clean the outer surfaces of sample bottles before and after sample collection; and
- Encasing the source of contaminants with plastic sheeting or overpacks.

Proper procedures for dressing prior to entrance into contaminated areas will minimize the potential for contaminants to bypass the protective clothing. Generally, all fasteners (zippers, buttons, snaps, etc.) should be used, gloves and boots tucked under or over sleeves and pant legs, and all junctures taped (see the Health and Safety Plan for these procedures).

Decontamination Methods

All personnel, samples, and equipment leaving the contaminated area of a site must be decontaminated to remove any chemicals or infectious organisms that may have adhered to them. Various decontamination methods will either physically remove, inactivate by chemical detoxification/disinfection/sterilization, or remove contaminants by both physical and chemical means.

In many cases, gross contamination can be removed by physical means. The physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods.

6.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The following reviews the available abrasive methods.

Mechanical

Mechanical methods include using brushes with metal, nylon, or natural bristles. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushing, and degree of brush contact. Material may also be removed by using appropriate tools to scrape, pry, or otherwise remove adhered materials.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, and time of air blasting dictate cleaning efficiency. The method's disadvantages are its inability to control the exact amount of material removed and its large amount of waste generated.

Wet Blasting

Wet blast cleaning involves the use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using very fine abrasives, the amount of materials removed can be carefully controlled.

6.2 Non-abrasive Cleaning Methods

Non-abrasive cleaning methods work by either dissolution or by forcing the contaminant off a surface with pressure. In general, less of the equipment surface is removed using non-abrasive methods.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and high-pressure hose. Operating pressure usually ranges from 340 to 680 psi, which relates to flow rates of 20 to 140 lpm.

Steam Cleaning

This method uses water delivered at high pressure and high temperature in order to remove accumulated solids and/or oils.

Ultra-High-Pressure Water

This system produces a water jet from 1,000 to 4,000 atm. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 m/sec. (1,000 atm) to 900 m/sec. (4,000 atm). Additives can be used to enhance the cleaning action, if approved by the QAPP for the project.

High-Pressure Freon Cleaning

Freon cleaning is a very effective method for cleaning cloth, rubber, plastic, and external/internal metal surfaces. Freon 113 (trichlorotriflorethane) is dense, chemically stable, relatively non-toxic, and leaves no residue. The vapor is easily removed from the air by activated charcoal. A high pressure (1,000 atm) jet of liquid Freon 113 is directed onto the surface to be cleaned. The Freon can be collected in a sump, filtered, and reused.

Physical removal of gross contamination should be followed by a wash/rinse process using cleaning solutions. One or more of the following methods utilize cleaning solutions.

Dissolving

Removal of surface contaminants can be accomplished by chemically dissolving them, although the solvent must be compatible with the equipment and protective clothing. Organic solvents include alcohols, ethers, ketones, aromatics, straight-chain alkanes, and common petroleum products. Halogenated solvents are generally incompatible with protective clothing and are toxic. Table 1 provides a general guide to the solubility of contaminant categories in four types of solvents.

Surfactants

Surfactants reduce adhesion forces between contaminants and the surface being cleaned and prevents reposition of the contaminants. Non-phosphate detergents dissolved in tap water is an acceptable surfactant solution.

Rinsing

Contaminants are removed and rinsing through dilution, physical attraction, and solubilization.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment and personal protective clothing.

6.3 Field Sampling Equipment Cleaning Procedures

The following steps for equipment cleaning should be followed for general field sampling activities.

1. Physical removal (abrasive or non-abrasive methods).
2. Scrub with non-phosphate detergent plus tap water.
3. Tap water rinse.
4. 10% nitric acid (required during sampling for inorganics only).
5. Distilled/deionized water rinse.
6. Solvent rinse (required during sampling for organics only).
7. Total air dry (required during sampling for organics only).
8. Triple rinse with distilled/deionized water.

Table 1 lists solvent rinses which may be required for elimination of particular chemicals. After each solvent rinse, the equipment should be air-dried and triple-rinsed with distilled/deionized water.

Solvent rinses are not necessarily required when organics are not a contaminant of concern. Similarly, an acid rinse is not necessarily required if analysis does not include inorganics.

NOTE: Reference the appropriate analytical procedure for specific decontamination solutions required for adequate removal of the contaminants of concern.

Sampling equipment that requires the use of plastic or teflon tubing should be disassembled, cleaned, and the tubing replaced with clean tubing, if necessary, before commencement of sampling or between sampling locations.

Table 1 Decontamination Solvents

Solvent	Soluble Contaminants
Water	Low-chain compounds Salts Some organic acids and other polar compounds
Dilute Bases For example: ■ detergent ■ soap	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents: For example: ■ alcohols (methanol) ■ ethers ■ ketones ■ aromatics ■ straight-chain alkanes (e.g., hexane) ■ common petroleum products (e.g., fuel oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)

WARNING: Some organic solvents can permeate and/or degrade the protective clothing.

7. Quality Assurance/Quality Control

QA/QC samples are intended to provide information concerning possible cross-contamination during collection, handling, preparation, and packing of samples from field locations for subsequent review and interpretation. A field blank (rinsate blank) provides an additional check on possible sources of contamination from ambient air and from sampling instruments used to collect and transfer samples into sample containers.

A field blank (rinsate blank) consists of a sample of analyte-free water passed through/over a precleaned/decontaminated sampling device and placed in a clean area to attempt to simulate a worst-case condition regarding ambient air contributions to sample contamination.

Field blanks should be collected at a rate of one per day per sample matrix even if samples are not shipped that day. The field blanks should return to the lab with the trip blanks originally sent to the field and be packed with their associated matrix.

The field blank places a mechanism of control on equipment decontamination, sample handling, storage, and shipment procedures. It is also indicative of ambient conditions and/or equipment conditions that may affect the quality of the samples.

Holding times for field blanks analyzed by CLP methods begin when the blank is received in the laboratory (as documented on the chain of parameters and associated analytical methods).

Holding times for samples and blanks analyzed by SW-846 or the 600 and 500 series begins at the time of sample collection.

8. Health and Safety

Decontamination can pose hazards under certain circumstances even though performed to protect health and safety. Hazardous substances may be incompatible with decontamination methods (i.e., the method may react with contaminants to produce heat, explosion, or toxic products). Decontamination methods may be incompatible with clothing or equipment (e.g., some solvents can permeate and/or degrade protective clothing). Also, a direct health hazard to workers can be posed from chemical decontamination solutions that may be hazardous if inhaled or may be flammable.

The decontamination solutions must be determined to be compatible before use. Any method that permeates, degrades, or damages personal protective equipment should not be used. If decontamination methods do pose a direct health hazard, measures should be taken to protect personnel or modified to eliminate the hazard.

All site-specific safety procedures should be followed for the cleaning operation. At a minimum, the following precautions should be taken:

1. Safety glasses with splash shields or goggles, neoprene gloves, and laboratory apron should be worn.

2. All solvent rinsing operations should be conducted under a fume hood or in open air.

3. No eating, smoking, drinking, chewing, or any hand-to-mouth contact is permitted.

9. References

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October 1985.

STANDARD OPERATING PROCEDURE

Title:	SAMPLE PACKAGING
Category:	ENV 3.16
Revised:	August 2008

SAMPLE PACKAGING

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TABLE OF CONTENTS

Section — Page

1. Introduction

Liquid and solid environmental samples are routinely collected by E & E during field surveys, site investigations, and other site visits for laboratory analysis. Unless the samples have anesthetic, noxious, or other properties that could inhibit the ability of a flight crew member to perform his or her duty or are known to meet the established U.S. Department of Transportation criteria for hazardous material (i.e., explosive, corrosive, flammable, poisonous), they are not regulated as hazardous materials.

This Standard Operating Procedure (SOP) describes the packaging procedures to be used by E & E's staff to ensure the safe arrival of the samples at the laboratory for analyses. These procedures have been developed to reduce the risk of damage to the samples (i.e., breakage of the sample containers), promote the maintenance of sample temperature within the cooler, and prevent spillage of the sampled material should a container be broken.

In the event the sample material meets the established criteria of a DOT hazardous material, the reader is referred to E & E's Hazardous Materials/Dangerous Goods Shipping Guidance Manual (see H&S 5.5).

2. Scope

This SOP describes procedures for the packaging of environmental samples in:

- Coolers;
- Steel, aluminum and plastic drums; and
- 4GV fiberboard boxes.

The Hazardous Materials/Dangerous Goods Shipping Guidance Manual will complete the information needed for shipping samples by providing guidance on:

- Hazard determination for samples which meet the USDOT definition of a hazardous material;
- Shipping profiles for "standard" shipments;
- Shipping procedures for "non-standard" shipments;
- Marking of packages containing hazardous materials;
- Labeling of packages containing hazardous materials; and
- Preparation of shipping papers for hazardous materials shipment.

3. Sample Packaging Procedures

3.1 General

It is E & E's intent to package samples so securely that there is no chance of leakage during shipment. This is to prevent the loss of samples and the expenditure of funds for emergency responses to spills and the efforts necessary to re-obtain the sample.

Over the years, E & E has developed several "standard" package configurations for the shipping of environmental samples. These standard package configurations are described below.

Liquid samples are particularly vulnerable. Because transporters (carriers) do not know the difference between a package leaking distilled water and a package leaking a hazardous chemical, they will react to a spill in an emergency fashion, potentially causing enormous expense to E & E for the cleanup of the sample material. Therefore, liquids are to be packed in multiple layers of plastic bags and absorbent/cushioning material to preclude any possibility of leaks from a package. This section defines the standard packaging configurations for environmental samples.

3.2 Liquid Environmental Sample Packaging Procedures

Liquid environmental samples should be collected and preserved as outlined in the Standard Operating Procedures (SOP) for Surface Water Sampling (ENV 3.12), and Groundwater Well Sampling (ENV 3.7). ***Preserved water samples are not considered to meet the HM/DG definitions of Class 8 (Corrosive) due to the preservative and are therefore considered to be nonhazardous samples.*** Liquid environmental samples may be shipped using an 80-quart cooler or an outer package consisting of either a steel or aluminum drum. Because the steel and aluminum drums provide little insulating capability, they should not be used for samples that require icing.

Packaging Liquid Environmental Samples Using the 80-Quart Cooler

- Label and seal all water sample bottles according to appropriate sampling SOPs;
- Secure the bottle caps using fiberglass tape; and
- Place each amber, poly, and volatile organic analysis (VOA) bottle in a sealable plastic bag. Mark the temperature blank VOA bag for identification.

If a foam block insert is used:

- Line the cooler with two plastic bags;
- Place a foam insert (with holes cut to receive the sample bottles) inside the plastic bag;

- Place the bottles in the holes in the foam block;
- Fill void spaces with bagged ice to the top of the cooler;
- Fold over the plastic bags lining the cooler and secure shut with tape;
- Place Chain-of-Custody (C-O-C) form in a sealable bag and tape it to the inside of the cooler lid; and
- Secure the cooler with strapping tape and custody seal. Cover the custody seals with clear tape.

If acceptable absorbent material is used:

- Place 1 inch of inert absorbent material in the bottom of the cooler;
- Line the cooler with two plastic bags;
- Place each sample bottle inside the inner bag;
- Fill the void spaces around the bottles with absorbent to about half the height of the large bottles;
- Fill the remainder of the void spaces with bagged ice to within 4 inches of the top of the cooler, making sure the VOAs are in direct contact with a bag of ice;
- Fold over the plastic bags lining the cooler and secure shut with tape;
- Fill the remaining space in the cooler with absorbent to the top of the cooler;
- Place C-O-C form in a sealable bag and tape it to the inside of the cooler lid; and
- Secure the cooler with strapping tape and custody seal. Cover the custody seals with clear tape.

Note: Acceptable absorbent materials must not react dangerously with the liquid and include vermiculite only if certified asbestos free.

Alternate Packaging Using 1A2/1B2 Drum

- Place 3 inches of inert absorbent material in the bottom of the drum;
- Line the drum with two plastic bags;
- Place each sample bottle inside the inner bag;

- Fill the void spaces around the bottles with absorbent to the height of the larger bottles;
- Fold over the plastic bags lining the drum and secure shut with tape;
- Fill the remaining space in the drum with absorbent to the top of the drum;
- Place C-O-C form in a sealable bag and tape it to the inside of the drum lid; and
- Secure the drum with closing ring and apply custody seals. Cover the custody seals with clear tape.

3.3 Soil/Sediment Environmental Sample Packaging Procedures

Soil/sediment environmental samples should be collected as outlined in the SOP for Soil Sampling (ENV 3.13), and SOP for Sediment Sampling (ENV 3.8). Soil/sediment environmental samples may be shipped using an 80-quart cooler, a 4GV fiberboard combination package, or an outer package consisting of either a steel or aluminum drum. Because the steel and aluminum drums provide little insulating capability, they should not be used for samples that require icing.

Packaging Soil/Sediment Environmental Samples

- Label and seal each sample container according to SOPs;
- Secure the bottle caps using fiberglass tape;
- Place each sample bottle inside a sealable plastic bag and place it in its original shipping box or in individual fiberboard boxes. Mark the temperature blank bag for identification; and
- Secure the original shipping box with strapping tape, place shipping box in a plastic bag, and secure the plastic bag with tape.

If an 80-quart cooler is used:

- Place bubble pack or similar material on the bottom and sides of an 80-quart cooler;
- Place the bagged shipping boxes in the cooler with a layer of bubble pack between each box;
- Fill the void spaces with "blue ice" or ice in baggies to the top of the cooler;
- Place C-O-C form in a sealable baggie and tape it to the inside of the cooler lid; and

- Secure the cooler with strapping tape and custody seal. Cover the seals with clear tape.

If a 1A2/1B2 drum is used:

- Place 3 inches of inert absorbent material in the bottom of the drum;
- Line the drum with two plastic garbage bags;
- Place the boxes inside the inner bag;
- Fill the space around the samples with absorbent;
- Fold over the plastic bags lining the drum and secure shut with tape;
- Fill the remaining space around the bags with absorbent to the top of the drum;
- Place C-O-C form in a sealable bag and tape it to the inside of the drum lid; and
- Secure the drum with the closing ring and apply custody seals. Cover the custody seals with clear tape.

Note: If a small number of samples are being shipped, it may be more practical to package them using the absorbent or foam block configurations used for shipping liquid samples.

4. Shipping Procedures

Environmental samples are to be shipped as nonhazardous cargo. Unless the samples have anesthetic, noxious, or other properties that could inhibit the ability of a flight crew member to perform his or her duty or are known to meet the established U.S. Department of Transportation criteria for a hazardous material (i.e., explosive, corrosive, flammable, poisonous), they are not regulated as hazardous materials. When preparing the containers (i.e., cooler, drum, or box) for shipment, E & E staff must remove all labels from the outside container. Labels indicating that the contents may be hazardous are misleading and are not appropriate. Markings indicating ownership of the container, destination, and chain of custody labels are acceptable and can be attached as required.

When completing the paperwork for shipment, the standard nonhazardous forms must be used. Do not use the hazardous materials/dangerous goods airbills, either in total or in part; these forms are coded and their use will invite unnecessary questions. This will only serve to confuse DHL or Federal Express' terminal personnel and will cause much frustration and the delay of sample shipment.

Environmental sample packages can be shipped overnight by both DHL and Federal Express. When choosing between the two, cost should be considered. It is normally much cheaper to ship DHL. In addition, DHL tends to have remote locations open later in the evenings than Federal Express, which may be helpful when trying to complete a full day's sampling effort and still make the flights on time. Although both companies offer pickup of samples at the site, it is advisable to call ahead and ensure that this service is offered beforehand. In almost all cases, both companies will deliver to the laboratory of your choice on Saturdays. When planning for sampling activities, check with the companies in advance to verify pick-up and delivery schedules.

Title:	SOIL SAMPLING
Category:	ENV 3.13
Revised:	August 1997

STANDARD OPERATING PROCEDURE

SOIL SAMPLING

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TITLE:	SOIL SAMPLING		
CATEGORY:	ENV 3.13	REVISED:	August 1997

TABLE OF CONTENTS

Appendix

LIST OF TABLES

Table | Page

LIST OF FIGURES

1. Introduction

This document describes the procedures for the collection of representative soil samples. Representative sampling ensures the accurate characterization of site conditions. Analysis of soil samples may determine pollutant concentrations and the accompanying risks to public health, welfare, or the environment.

2. Scope

Included in this discussion are procedures for obtaining representative samples, quality assurance/quality control (QA/QC) measures, proper documentation of sampling activities, and recommendations for personnel safety.

3. Method Summary

Soil samples may be recovered using a variety of methods and equipment. These are dependent on the depth of the desired sample, the type of sample required (disturbed vs. undisturbed), and the soil type.

Samples of near-surface soils may be easily obtained using a spade, stainless-steel spoon, trowel, or scoop. Sampling at greater depths may be performed using a hand auger; a power auger; or, if a test pit is required, a backhoe.

All sampling devices should be cleaned using pesticide-grade acetone (assuming that acetone is not a target compound) or methanol, then wrapped in clean aluminum foil, and custody sealed for identification. The sampling equipment should remain in this wrapping until it is needed. Each sampler should be used for one sample only. However, dedicated tools may be impractical if there is a large number of soil samples required. In this case, samplers should be cleaned in the field using standard decontamination procedures as outlined in E & E's Standard Operating Procedure (SOP) for Sampling Equipment Decontamination (see ENV 3.15).

4. Sample Preservation, Containers, Handling, and Storage

The chemical preservation of solids is not generally recommended. Refrigeration is usually the best approach, supplemented by a minimal holding time.

Soil samples should be handled according to the procedures outlined in E & E's SOP for Sample Packaging (see ENV 3.16).

5. Potential Problems

Potential problems with soil sampling include cross-contamination of samples and improper sample collection. Cross-contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and bottles. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection is generally the result of the use of contaminated equipment; the disturbance of the matrix, resulting in compaction of the sample; and inadequate homogenization of the sample where required, resulting in variable, nonrepresentative results. Specific advantages and disadvantages of soil sampling equipment are presented in Table 5-1.

Table 5-1 Soil Sampling Equipment

Equipment	Applicability	Advantages and Disadvantages
Trier	Soft surface soil	Inexpensive; easy to use and decontaminate; difficult to use in stony, dry, or sandy soil.
Scoop, trowel, spoon, or spatula	Soft surface soil	Inexpensive; easy to use and decontaminate; trowels with painted surfaces should be avoided.
Tulip bulb planter	Soft soil, 0 to 6 inches	Easy to use and decontaminate; uniform diameter and sample volume; preserves soil core (suitable for volatile organic analysis (VOA) and undisturbed sample collection); limited depth capability; not useful for hard soils.
Spade or shovel	Medium soil, 0 to 12 inches	Easy to use and decontaminate; inexpensive; can result in sample mixing and loss of volatile organic compounds (VOCs).
Vehimeyer soil outfit	Soil, 0 to 10 feet	Difficult to drive into dense or hard material; can be difficult to pull from ground.
Soil coring device and auger	Soft soil, 0 to 24 inches	Relatively easy to use; preserves soil core (suitable for VOA and undisturbed sample collection); limited depth capability; can be difficult to decontaminate.
Thin-walled tube sampler	Soft soil, 0 to 10 feet	Easy to use; preserves soil core (suitable for VOA and undisturbed sample collection); may be used to help maintain integrity of VOA samples; easy to decontaminate; can be difficult to remove cores from sampler.
Split-spoon sampler	Soil, 0 inches to bedrock	Excellent depth range; preserves soil core (suitable for VOA and undisturbed sample collection); acetate sleeve may be used to help maintain integrity of VOA samples; useful for hard soils; often used in conjunction with drill rig for obtaining deep cores.

Table 5-1 Soil Sampling Equipment

Equipment	Applicability	Advantages and Disadvantages
Shelby tube sampler	Soft soil, 0 inches to bedrock	Excellent depth range; preserves soil core (suitable for VOA and undisturbed sample collection); tube may be used to ship sample to lab undisturbed; may be used in conjunction with drill rig for obtaining deep cores and for permeability testing; not durable in rocky soils.
Laskey sampler	Soil, 0 inches to bedrock	Excellent depth range; preserves soil cores; used in conjunction with drill rig for obtaining deep core; can be difficult to decontaminate.
Bucket auger	Soft soil, 3 inches to 10 feet	Easy to use; good depth range; uniform diameter and sample volume; acetate sleeve may be used to help maintain integrity of VOA samples; may disrupt and mix soil horizons greater than 6 inches in thickness.
Hand-operated power auger	Soil, 6 inches to 15 feet	Good depth range; generally used in conjunction with bucket auger for sample collection; destroys soil core (unsuitable for VOA and undisturbed sample collection); requires two or more equipment operators; can be difficult to decontaminate; requires gasoline-powered engine (potential for cross-contamination).
Continuous-flight auger	Soil, 0 inches to bedrock	Excellent depth range; easy to decontaminate; can be used on all soil samples; results in soil mixing and loss of VOCs.
Dutch auger	Designed specifically for wet, fibrous, or rooted soils (e.g., marshes)	
Eijkelcamp stoney soil auger	Stoney soils and asphalt	
Backhoe	Soil, 0 inches to 10 feet	Good depth range; provides visual indications as to depth of contaminants; allows for recovery of samples at specific depths; can result in loss of VOCs and soil mixing; shoring required at depth.

Note: Samplers may not be suitable for soils with coarse fragments.
Augers are suitable for soils with limited coarse fragments; only the stoney auger will work well in very gravelly soil.

6. Soil Sampling Equipment

Soil Sampling Equipment List

- Stainless-steel spoon
- Trier
- Scoop
- Trowel

- Spatula
- Stainless-steel tulip bulb planter
- Spade or shovel
- Vehimeyer soil sampler outfit
  - tubes
  - points
  - drive head
  - drop hammer
  - fuller jack and grip
- Soil-coring device
- Thin-walled tube sampler
- Split-spoon sampler
- Shelby tube sampler
- Laskey sampler
- Bucket auger
- Hand-operated power auger
- Continuous-flight auger
- Dutch auger
- Eijkelcamp stoney soil auger
- Backhoe
- Hand auger with replaceable sleeves

Sampling Support Equipment and Documentation List

- Sampling plan
- Sample location map
- Safety equipment, as specified in the Health and Safety Plan
- Decontamination supplies and equipment, as described in the Work Plan
- Compass
- Tape measure
- Survey stakes or flags
- Camera
- Stainless-steel buckets or bowls
- Sample containers, precleaned (e.g., I-Chem)
- Logbook
- Chain-of-custody forms
- Plastic sheet
- Soil gas probes
- Infiltrometer
- Pounding sleeve
- Extension rods
- T-handle

Labeling, Packaging, and Shipping Supplies

- Coolers
- Labels for sample containers and coolers (e.g., "fragile")
- Ice
- Plastic bags for sample containers and ice
- ESC paint cans and clamps for polychlorinated biphenyl sampling
- Vermiculite (only if certified asbestos free) or other absorbent
- Duct and strapping tape
- Federal Express airbills and pouches

6.1 Geophysical Equipment

Geophysical techniques can be integrated with field analytical and soil sampling equipment to help define areas of subsurface contamination. For a description of the geophysical techniques and associated applications, refer to E & E's SOP for Surface Geophysical Techniques (see GEO 4.2).

7. Reagents

This procedures does not require the use of reagents except for decontamination of equipment, as required. Refer to E & E's SOP for Sampling Equipment Decontamination (see ENV 3.15) and the Site-Specific Work Plan for proper decontamination procedures and appropriate solvents.

8. Procedures

8.1 Office Preparation

1. The preparation of a Health and Safety Plan is required prior to any sampling. The plan must be approved and signed by the Corporate Health and Safety Officer or his/her designee (i.e., the Regional Safety Coordinator).

2. Prepare a Sampling Plan to meet the data quality objectives of the project in accordance with contract requirements. Review available background information (i.e., topographic maps, soil survey maps, geologic maps, other site reports, etc.) to determine the extent of the sampling effort, the sampling method to be employed, and the type and amounts of equipment and supplies required.

3. Obtain necessary sampling and monitoring equipment (see Section 6), decontaminate or preclean the equipment, and ensure that it is in working order.

4. Contact the delivery service to confirm the ability to ship all equipment and samples. Determine whether shipping restrictions exist.

5. Prepare schedules and coordinate with staff, clients, and regulatory agencies, if appropriate.

8.2 Field Preparation

1. Identify local suppliers of sampling expendables (e.g., ice and plastic bags) and overnight delivery services (e.g., Federal Express).

2. Decontaminate or preclean all equipment before soil sampling, as described in E & E's SOP for Sampling Equipment Decontamination (see ENV 3.15), or as deemed necessary.

3. A general site survey should be performed prior to site entry in accordance with the Health and Safety Plan, followed by a site safety meeting.

4. Identify and stake all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations will be utility-cleared by the property owner or field team prior to soil sampling.

8.3 Representative Sample Collection

The objective of representative sampling is to ensure that a sample or group of samples adequately reflects site conditions.

8.3.1 Sampling Approaches

It is important to select an appropriate sampling approach for accurate characterization of site conditions. Each approach is defined below. Table 8-1 summarizes the following sampling approaches and ranks them from most to least suitable based on the sampling objective.

8.3.1.1 Judgmental Sampling

Judgmental sampling is based on the subjective selection of sampling locations relative to historical site information, on-site investigation (site walk-over), etc. There is no randomization associated with this sampling approach because samples are collected primarily at areas of suspected highest contaminant concentrations. Therefore, any statistical calculations based on the sampling results would be unfairly biased.

Table 8-1 Representative Sampling Approach Comparison

Sampling Objective	Judgmental	Random	Stratified Random	Systematic Grid	Systematic Random	Search	Transect
Establish Threat	1	4	3	2[a]	3	3	2
Identify Sources	1	4	2	2[a]	3	2	3
Delineate Extent of Contamination	4	3	3	1[b]	1	1	1
Evaluate Treatment and Disposal Options	3	3	1	2	2	4	2
Confirm Cleanup	4	1[c]	3	1[b]	1	1	1[c]

1 Preferred approach.
2 Acceptable approach.
3 Moderately acceptable approach.
4 Least acceptable approach.
a Should be used with field analytical screening.
b Preferred only where known trends are present.
c Allows for statistical support of cleanup verification if sampling over entire site.

8.3.1.2 Random Sampling

Random sampling involves the arbitrary collection of samples within a defined area. Refer to EPA 1984 and EPA 1989 for a random number table and guidelines on selecting sample coordinates. The arbitrary selection of sample locations requires each sample location to be chosen independently so that results in all locations within the area of concern have an equal chance of being selected. To facilitate statistical probabilities of contaminant concentration, the area of concern must be homogeneous with respect to the parameters being monitored. Thus, the higher the degree of heterogeneity, the less the random sampling approach will reflect site conditions (see Figure 8-1).

8.3.1.3 Stratified Random Sampling

Stratified random sampling relies primarily on historical information and prior analytical results to divide the area of concern into smaller sampling areas, or "strata." Strata can be defined by several factors, including sampling depth, contaminant concentration levels, and contaminant source areas. Sampling locations should be selected within a strata using random selection procedures (see Figure 8-2).

8.3.1.4 Systematic Grid Sampling

Systematic grid sampling involves the division of the area of concern into smaller sampling areas using a square or triangular grid. Samples are then collected from the intersections of the grid lines, or "nodes." The origin and direction for placement of the grid should be selected by using an initial random point. The distance between nodes is dependent upon the size of the area of concern and the number of samples to be collected (see Figure 8-3).

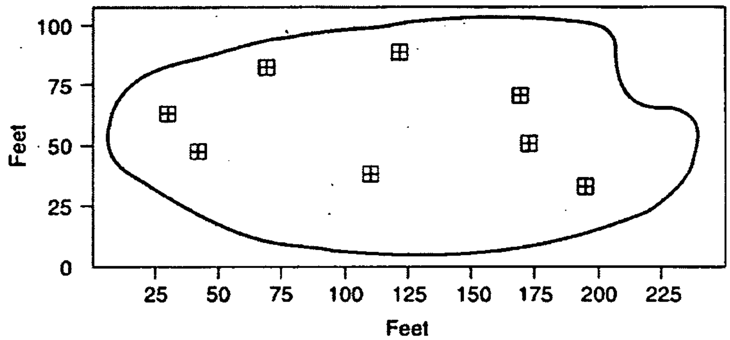


Figure 8-1 Random Sampling**

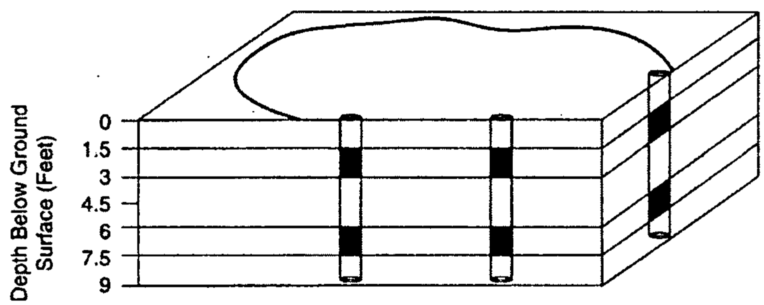


Figure 8-2 Stratified Random Sampling

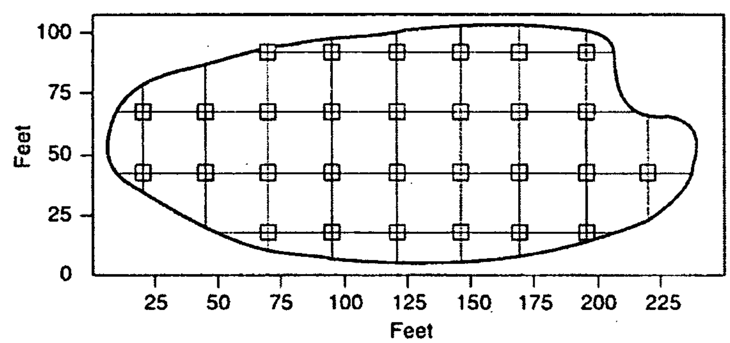


Figure 8-3 Systematic Grid Sampling**

** After EPA, February 1989

Legend
- —— Sample Area Boundary
- ⊞ Selected Sample Location
- ■ Sample Location

8.3.1.5 Systematic Random Sampling

Systematic random sampling involves dividing the area of concern into smaller sampling areas as described in Section 8.3.1.4. Samples are collected within each grid cell using random selection procedures (see Figure 8-4).

8.3.1.6 Biased-Search Sampling

Search sampling utilizes a systematic grid or systematic random sampling approach to define areas where contaminants exceed cleanup standards (i.e., hot spots). The distance between the grid lines and number of samples to be collected are dependent upon the acceptable level of error (i.e., the chance of missing a hot spot). This sampling approach requires that assumptions be made regarding the size, shape, and depth of hot spots (see Figure 8-5).

8.3.1.7 Transect Sampling

Transect sampling involves establishing one or more transect lines, parallel or nonparallel, across the area of concern. If the lines are parallel, this sampling approach is similar to systematic grid sampling. The advantage of transect sampling over systematic grid sampling is the relative ease of establishing and relocating transect lines as opposed to an entire grid. Samples are collected at regular intervals along the transect line at the surface and/or at a specified depth(s). The distance between the sample locations is determined by the length of the line and the number of samples to be collected (see Figure 8-6).

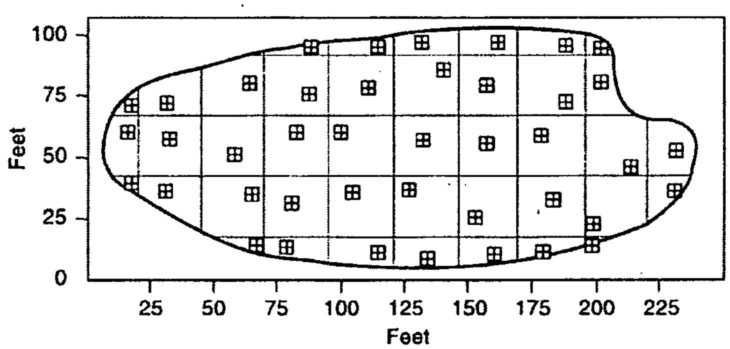


Figure 8-4 Systematic Random Sampling

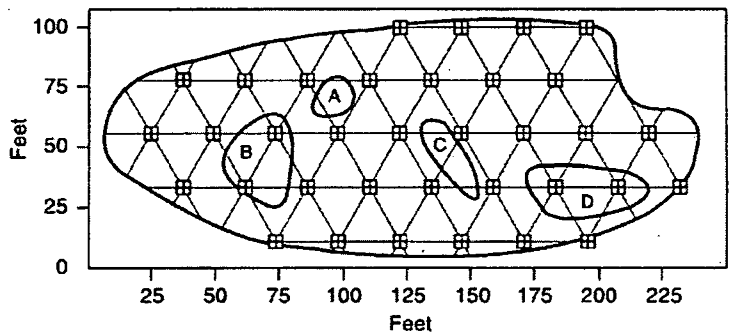


Figure 8-5 Search Sampling

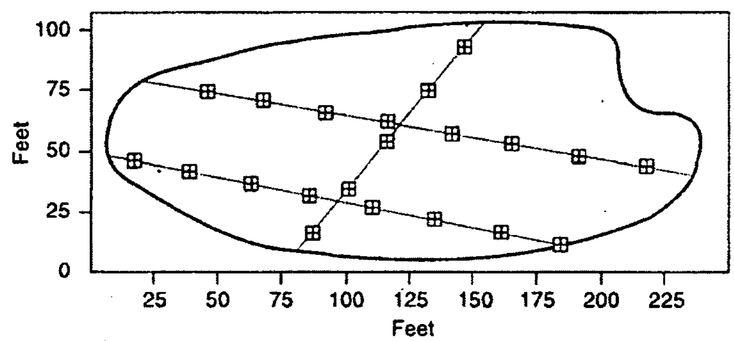
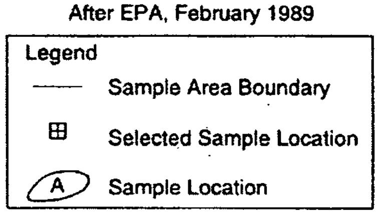


Figure 8-6 Transect Sampling

After EPA, February 1989



8.3.2 Surface Soil Samples

Collection of samples from near-surface soil can be accomplished with tools such as spades, spoons, shovels, and scoops. The surface material can be removed to the required depth with this equipment; stainless-steel or plastic scoops can then be used to collect the sample.

This method can be used in most soil types, but is limited to sampling near-surface areas. Accurate, representative samples can be collected with this procedure, depending on the care and precision demonstrated by the sampling technician. The use of a flat, pointed mason trowel to cut a block of the desired soil can be helpful when undisturbed profiles are required (e.g., for volatile organic analyses [VOAs]). A stainless-steel scoop, lab spoon, or plastic spoon will suffice in most other applications. Care should be exercised to avoid the use of devices plated with chrome or other materials, as is common with garden implements such as potting trowels.

Soil samples are collected using the following procedure:

1. Carefully remove the top layer of soil to the desired sample depth with a precleaned spade;

2. Using a precleaned, stainless-steel scoop, spoon, trowel, or plastic spoon, remove and discard the thin layer of soil from the area that came into contact with the shovel;

3. Transfer the sample into an appropriate container using a stainless-steel or plastic lab spoon or equivalent. If composite samples are to be collected, place the soil sample in a stainless-steel or plastic bucket and mix thoroughly to obtain a homogeneous sample representative of the entire sampling interval. Place the soil samples into labeled containers. **(Caution: Never composite VOA samples)**;

4. VOA samples should be collected directly from the bottom of the hole before mixing the sample to minimize volatilization of contaminants;

5. Check to ensure that the VOA vial Teflon liner is present in the cap, if required. Fill the VOA vial fully to the top to reduce headspace. Secure the cap tightly. The chemical preservation of solids is generally not recommended. Refrigeration is usually the best approach, supplemented by a minimal holding time;

6. Ensure that a sufficient sample size has been collected for the desired analysis, as specified in the Sampling Plan;

7. Decontaminate equipment between samples according to E & E's SOP for Sampling Equipment Decontamination (see ENV 3.15); and

8. Fill in the hole and replace grass turf, if necessary.

QA/QC samples should be collected as specified, according to the Work Plan.

8.3.3 Sampling at Depth with Augers and Thin-Walled Tube Samplers

This system consists of an auger, a series of extensions, a T-handle, and a thin-walled tube. The auger is used to bore a hole to a desired sampling depth and is then withdrawn. The auger tip is then replaced with a tube core sampler, lowered down the borehole, and driven into the soil to the completion depth. The core is then withdrawn and the sample is collected.

Several augers are available, including bucket type, continuous-flight (screw), and post-hole augers. Because they provide a large volume of sample in a short time, bucket types are better for direct sample recovery. When continuous-flight augers are used, the sample can be collected directly off the flights, usually at 5-foot intervals. The continuous-flight augers are satisfactory for use when a composite of the complete soil column is desired. Posthole augers have limited utility for sample collection because they are designed to cut through fibrous, rooted, swampy soil.

The following procedures will be used for collecting soil samples with the hand auger:

1. Attach the auger bit to a drill rod extension, and attach the T-handle to the drill rod.
2. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, and litter). It may be advisable to remove the first 3 to 6 inches of surface soil from an area approximately 6 inches in radius around the drilling location.
3. Begin augering, periodically removing and depositing accumulated soils onto a canvas or plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole and avoids possible contamination of the surrounding area.
4. After reaching the desired depth, slowly and carefully remove the auger from the boring. When sampling directly from the auger, collect the sample after the auger is removed from the boring and proceed to Step 11.
5. A precleaned stainless-steel auger sleeve can also be used to collect a sample. After reaching the desired sampling depth, remove the auger and place the sleeve inside the auger. Collect the sample with the auger. Remove the auger from the boring. The sample will be collected only from the sleeve. The soil from the auger tip should never be used for the sample.
6. Remove the auger tip from the dill rods and replace with a precleaned thin-walled tube sampler. Install the proper cutting tip.
7. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the soil. Care should be taken to avoid scraping the borehole sides. Avoid hammering the drill rods to facilitate coring, because the vibrations may cause the boring walls to collapse.
8. Remove the tube sampler and unscrew the drill rods.
9. Remove the cutting tip and core from the device.
10. Discard the top of the core (approximately 1 inch), because this represents material collected before penetration of the layer in question. Place the remaining core into the sample container.

11. If required, ensure that a Teflon liner is present in the cap. Secure the cap tightly onto the sample container. Place the sample bottle in a plastic bag and put on ice to keep the sample at 4°Celsius.

12. Carefully and clearly label the container with the appropriate sample tag, addressing all the categories or parameters listed in E & E's SOP for Sample Packaging and Shipping (see ENV 3.16).

13. Use the chain-of-custody form to document the types and numbers of soil samples collected and logged. Verify that the chain-of-custody form is correctly and completely filled out.

14. Record the time and date of sample collection, as well as a description of the sample, in the field logbook.

15. If another sample is to be collected in the sample hole, but at a greater depth, re-attach the auger bit to the drill and assembly, and follow Steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.

16. Abandon the hole according to applicable regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

17. Decontaminate the sampling equipment per E & E's SOP for Sampling Equipment Decontamination (see ENV 3.15).

8.3.4 Sampling at Depth with a Trier

1. Insert the trier into the material to be sampled at a 0° to 45° angle from horizontal. This orientation minimizes the spillage of sample material. Extraction of samples may require tilting of the containers.

2. Rotate the trier once or twice to cut a core of material.

3. Slowly withdraw the trier, making sure that the slot is facing upward.

4. Transfer the sample into a suitable container with the aid of a spatula and brush.

5. If required, ensure that a Teflon liner is present in the cap. Secure the cap tightly onto the sample container. Samples are handled in accordance with E & E's SOP for Sample Packaging and Shipping (see ENV 3.16).

6. Carefully and clearly label the container with the appropriate sample tag, addressing all the categories or parameters listed in E & E's SOP for Sample Packaging and Shipping (see ENV 3.16).

7. Use the chain-of-custody form to document the types and numbers of soil samples collected and logged.

8. Record the time and date of sample collection as well as a description of the sample and any associated air monitoring measurements in the field logbook.

9. Abandon the hole according to applicable regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

10. Decontaminate sampling equipment per E & E's SOP for Sampling Equipment Decontamination (see ENV 3.15).

8.3.5 Sampling at Depth with a Split-Spoon (Barrel) Sampler

The procedure for split-spoon sampling describes the extraction of undisturbed soil cores of 18 or 24 inches in length. A series of consecutive cores may be sampled to give a complete soil column, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extraction.

This sampling device may be used to collect information such as soil density. All work should be performed in accordance with American Society for Testing and Materials (ASTM) D 1586-84, *Penetration Test and Split Barrel Sampling of Soils*.

1. Assemble the sampler by aligning both sides of the barrel and then screwing the bit on the bottom and the heavier head piece on top. Install a retaining cap in the head piece if necessary.

2. Place the sampler in a perpendicular position on the sample material.

3. Using a sledge hammer or well ring, if available, drive the tube. Do not drive past the bottom of the head piece because compression of the sample will result.

4. Record the length of the tube used to penetrate the material being sampled and the number of blows required to obtain this depth.

5. Withdraw the split spoon and open by unscrewing the bit and head. If a split sample is desired, a clean stainless-steel knife should be used to divide the tube contents in half, lengthwise. This sampler is available in 2- and 3.5-inch diameters. The required sample volume may dictate the use of the larger barrel. If needed, stainless-steel or Teflon sleeves can be used inside the split-spoon. If sleeves removed from the split-spoon are capped immediately, volatilization of contaminants can be reduced. When split-spoon sampling is performed to gain geologic information, all work should be performed in accordance with ASTM D 1586-67 (reapproved in 1974).

6. Cap the sample container, place in a double plastic bag, and attach the label and custody seal. Record all pertinent data in the field logbook and complete the sample analysis request form and chain-of-custody record before collecting the next sample.

7. If required, preserve or place the sample on ice.

8. Follow proper decontamination procedures and deliver samples to the laboratory for analysis.

8.3.6 Test Pit/Trench Excavation

These relatively large excavations are used to remove sections of soils when detailed examination of soil characteristics (horizontal, structure, color, etc.) is required. It is the least cost-effective sampling method because of the relatively high cost of backhoe operation.

1. Prior to any excavations with a backhoe, it is important to ensure that all sampling locations are clear of utility lines and poles (subsurface as well as above surface).

2. Using the backhoe, a trench is dug to approximately 3 feet in width and approximately 1 foot below the cleared sampling depth. Place removed or excavated soils on canvas or plastic sheets, if necessary. Trenches greater than 4 feet deep must be sloped or protected by a shoring system, as required by Occupational Safety and Health Administration (OSHA) regulations.

3. A shovel is used to remove a 1- to 2-inch layer of soil from the vertical face of the pit where sampling is to be done.

4. Samples are collected using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose soil for sampling. Samples are removed and placed in an appropriate container.

5. If required, ensure that a Teflon liner is present in the cap. Secure the cap tightly onto the sample container. Samples are handled in accordance with E & E's SOP for Sample Packaging and Shipping (see ENV 3.16).

6. Carefully and clearly label the container with the appropriate sample tag, addressing all the categories or parameters listed in E & E's SOP for Sample Packaging and Shipping (see ENV 3.16).

7. Use the chain-of-custody form to document the types and numbers of soil samples collected and logged.

8. Record the time and date of sample collection as well as a description of the sample and any associated air monitoring measurements in the field logbook.

9. Abandon the hole according to applicable state regulations. Generally, excavated holes can simply be backfilled with the removed soil material.

10. Decontaminate sampling equipment, including the backhoe bucket, per E & E's SOP for Sampling Equipment Decontamination (see ENV 3.15).

8.4 Sample Preparation

In addition to sampling equipment, representative sample collection includes sample quantity, volume, preservation, and holding time (see Table 8-2). *Sample preparation* refers to all aspects of sample handling after collection. How a sample is prepared can affect its representativeness. For example, homogenizing can result in a loss of volatiles and is therefore inappropriate when volatile contaminants are the concern.

8.4.1 Sample Quantity and Volume

The volume and number of samples necessary for site characterization will vary according to the budget, project schedule, and sampling approach.

8.4.2 Sample Preservation and Holding Time

Sample preservation and holding times are as discussed in Section 4.

8.4.3 Removing Extraneous Material

Discard materials in a sample that are not relevant for site or sample characterization (e.g., glass, rocks, and leaves), because their presence may introduce an error in analytical procedures.

8.4.4 Homogenizing Samples

Homogenizing is the mixing of a sample to provide a uniform distribution of the contaminants. Proper homogenization ensures that the containerized samples are representative of the total soil sample collected. All samples to be composited or split should be homogenized after all aliquots have been combined. Do not homogenize samples for volatile compound analysis.

Table 8-2 Standard Sampling Holding Times, Preservation Methods, and Volume Requirements

Protocol Parameter	Holding Time		Minimum Volume Required		Container Type		Preservation	
	Soil	Water	Soil	Water	Soil	Water	Soil	Water
SW-846								
VOA[c]	14 days from date sampled	14 days from date sampled	15 g	One 40-mL vial; no air space	Two 40-mL vials; no air space	Two 40-mL vials; no air space	Cool to 4°C (ice in cooler)	Add HCl until pH <2 and cool to 4° (ice in cooler)
Semi-VOA (BNAs)[c]	14 days to extract from date sampled	7 days to extract from date sampled	30 g	1 L	8-oz. glass jar with Teflon-lined cap	½-gallon amber glass bottle	Cool to 4°C (ice in cooler)	Cool to 4°C (ice in cooler)
PCBs[d,e]	14 days to extract from date sampled	7 days to extract from date sampled	30 g	1 L	4-oz. glass jar with Teflon-lined cap	½-gallon amber glass bottle	Cool to 4°C (ice in cooler)	Cool to 4°C (ice in cooler)
Pesticides/PCBs[d,e]	14 days to extract from date sampled	7 days to extract from date sampled	30 g	1 L	8-oz. glass jar with Teflon-lined cap	½-gallon amber glass bottle	Cool to 4°C (ice in cooler)	Cool to 4°C (ice in cooler)
Metals[c]	6 months from date sampled	6 months from date sampled	10 g	300 mL	8-oz. glass jar with Teflon-lined cap	1-L polyethylene bottle with polyethylene-lined cap	Cool to 4°C (ice in cooler)	Add HNO_3 until pH <2 and cool to 4°C (ice in cooler)
Cyanide[c]	14 days from date sampled	14 days from date sampled	10 g	100 mL	8-oz. glass jar with Teflon-lined cap	1-L polyethylene bottle with polyethylene-lined cap	Cool to 4°C (ice in cooler)	Add NaOH until pH >12 and cool to 4°C (ice in cooler)
Hexavalent chromium[a]	24 hours from time sampled	24 hours from time sampled	10 g	50 mL	8-oz. glass jar with Teflon-lined cap	125-mL polyethylene bottle with polyethylene-lined cap	Cool to 4°C (ice in cooler)	Cool to 4°C (ice in cooler)
Total Organic Carbon (TOC)[a]	NA	28 days from date sampled	5 g	10 mL	8-oz. glass jar with Teflon-lined cap	125-mL polyethylene bottle with polyethylene-lined cap	Cool to 4°C (ice in cooler)	Add H_2SO_4 until pH <2 and cool to 4°C (ice in cooler)
Total Organic Halides (TOX)	NA	7 days from date sampled	100 g	200 mL	8-oz. glass jar with Teflon-lined cap	1-L amber glass bottle	Cool to 4°C (ice in cooler)	Add H_2SO_4 until pH <2 and cool to 4°C (ice in cooler)

Table 8-2 Standard Sampling Holding Times, Preservation Methods, and Volume Requirements

Protocol Parameter	Holding Time		Minimum Volume Required		Container Type		Preservation	
	Soil	Water	Soil	Water	Soil	Water	Soil	Water
Total Recoverable Petroleum Hydrocarbons[c]	28 days from date sampled	28 days from date sampled	50 g	1 L	8-oz. glass jar with Teflon-lined cap	1-L amber glass bottle	Cool to 4°C (ice in cooler)	Add H_2SO_4 until pH <2 and cool to 4°C (ice in cooler)
EPA-CLP								
VOA[c]	10 days from date received	10 days from date received	15 g	One 40-mL vial; no air space	Two 40-mL vials; no air space	Two 40-mL vials; no air space	Cool to 4°C (ice in cooler)	Add HCl until pH <2 and cool to 4°C (ice in cooler)
Semi-VOA (BNAs)[c]	10 days to extract from date received	5 days to extract from date received	30 g	1 L	8-oz. glass jar with Teflon-lined cap	½-gallon amber glass bottle	Cool to 4°C (ice in cooler)	Cool to 4°C (ice in cooler)
PCBs[d,e]	10 days to extract from date received	5 days to extract from date received	30 g	1 L	4-oz. glass jar with Teflon-lined cap	½-gallon amber glass bottle	Cool to 4°C (ice in cooler)	Cool to 4°C (ice in cooler)
Pesticides/PCBs[d,e]	10 days to extract from date received	5 days to extract from date received	30 g	1 L	8-oz. glass jar with Teflon-lined cap	½-gallon amber glass bottle	Cool to 4°C (ice in cooler)	Cool to 4°C (ice in cooler)
Metals[c]	6 months from date sampled	6 months from date sampled	10 g	300 mL	8-oz. glass jar with Teflon-lined cap	1-L polyethylene bottle with polyethylene-lined cap	Cool to 4°C (ice in cooler)	Add HNO_3 to pH <2 and cool to 4°C (ice in cooler)
Cyanide[c]	12 days from date received	12 days from date received	10 g	100 mL	8-oz. glass jar with Teflon-lined cap	1-L polyethylene bottle with polyethylene-lined cap	Cool to 4°C (ice in cooler)	Add NaOH to pH >12 and cool to 4°C (ice in cooler)
NYSDEC-CLP								
VOA[c]	7 days from date received	10 days from date received	15 g	One 40-mL vial; no air space	Two 40-mL vials; no air space	Two 40-mL vials; no air space	Cool to 4°C (ice in cooler)	Add HCl until pH <2 and cool to 4°C (ice in cooler)
Semi-VOA (BNAs)[c]	5 days to extract from date received	5 days to extract from date received	30 g	1 L	8-oz. glass jar with Teflon-lined cap	½-gallon amber glass bottle	Cool to 4°C (ice in cooler)	Cool to 4°C (ice in cooler)

Table 8-2 Standard Sampling Holding Times, Preservation Methods, and Volume Requirements

Protocol Parameter	Holding Time		Minimum Volume Required		Container Type		Preservation	
	Soil	Water	Soil	Water	Soil	Water	Soil	Water
PCBs[d,e]	5 days to extract from date received	5 days to extract from date received	30 g	1 L	4-oz. glass jar with Teflon-lined cap	½-gallon amber glass bottle	Cool to 4°C (ice in cooler)	Cool to 4°C (ice in cooler)
Pesticides/PCBs[d,e]	5 days to extract from date received	5 days to extract from date received	30 g	1 L	8-oz. glass jar with Teflon-lined cap	½-gallon amber glass bottle	Cool to 4°C (ice in cooler)	Cool to 4°C (ice in cooler)
Metals[c]	6 months from date sampled	6 months from date sampled	10 g	300 mL	8-oz. glass jar with Teflon-lined cap	1-L polyethylene bottle with polyethylene-lined cap	Cool to 4°C (ice in cooler)	Add HNO_3 to pH <2 and cool to 4°C (ice in cooler)
Cyanide[c]	12 days from date received	12 days from date received	10 g	100 mL	8-oz. glass jar with Teflon-lined cap	1-L polyethylene bottle with polyethylene-lined cap	Cool to 4°C (ice in cooler)	Add NaOH to pH >12 and cool to 4°C (ice in cooler)
EPA Water and Waste								
Total Dissolved Solids (TDS)	NA	7 days from date sampled	NA	200 mL	NA	1-L polyethylene bottle with polyethylene-lined cap	NA	Cool to 4°C (ice in cooler)

Note: All sample bottles will be prepared in accordance with EPA bottle-washing procedures. These procedures are incorporated in E & E's Laboratory and Field Personnel Chain-of-Custody Documentation and Quality Assurance/Quality Control Procedures Manual, July 1987.

[a] Technical requirements for sample holding times have been established for water matrices only. However, they are also suggested for use as guidelines in evaluating soil data.
[b] Holding time for GC/MS analysis is 7 days if samples are not preserved.
[c] Maximum holding time for mercury is 28 days from time sampled.
[d] If one container has already been collected for PCB analysis, then only one additional container need be collected for extractable organic, BNA, or pesticides/PCB analysis.
[e] Extra containers required for MS/MSD.

Key:

NA = Not applicable.

8.4.5 Compositing Samples

Compositing is the process of physically combining and homogenizing several individual soil aliquots of the same volume or weight. Compositing samples provides an average concentration of contaminants over a certain number of sampling points. Compositing dilutes high-concentration aliquots; therefore, detection limits should be reduced accordingly. If the composite area is heterogeneous in concentration and its composite value is to be compared to a particular action level, then that action level must be divided by the total number of aliquots making up the composite for accurate determination of the detection limit.

8.4.6 Splitting Samples

Splitting samples (after preparation) is performed when multiple portions of the same samples are required to be analyzed separately. Fill the sample containers simultaneously with alternate spoonfuls of the homogenized sample (see Figure 8-7).

8.5 Post-Operations

8.5.1 Field

Decontaminate all equipment according to E & E's SOP for Sampling Equipment Decontamination (see ENV 3.15).

8.5.2 Office

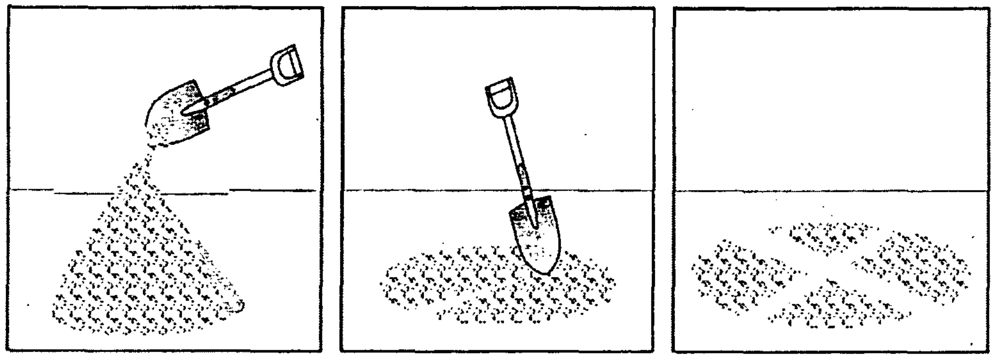
Organize field notes into a report format and transfer logging information to appropriate forms.

9. Calculations

There are no specific calculations required for these procedures.

10. Quality Assurance/Quality Control

The objective of QA/QC is to identify and implement methodologies that limit the introduction of error into sampling and analytical procedures.



Step 1:

- Cone Sample on hard, clean surface
- Mix by forming new cone

Step 2:

- Quarter after flattening cone

Step 3:

- Divide sample into quarters

Step 4:

- Remix opposite quarters
- Reform cone
- Repeat a minimum of 5 times

After: ASTM Standard C702-87

Figure 8-7 Quartering to Homogenized and Split Samples

10.1 Sampling Documentation

10.1.1 Soil Sample Label

All soil samples shall be documented in accordance with E & E's SOP for Sample Packaging and Shipping (see ENV 3.16). The soil sample label is filled out prior to collecting the sample and should contain the following:

1. Site name or identification.
2. Sample location and identifier.
3. Date samples were collected in a day, month, year format (e.g., 03 Jan 88 for January 3, 1988).
4. Time of sample collection, using 24-hour clock in the hours:minutes format.
5. Sample depth interval. Units used for depths should be in feet and tenths of feet.
6. Preservatives used, if any.
7. Analysis required.

8. Sampling personnel.

9. Comments and other relevant observations (e.g., color, odor, sample technique).

10.1.2 Logbook

A bound field notebook will be maintained by field personnel to record daily activities, including sample collection and tracking information. A separate entry will be made for each sample collected. These entries should include information from the sample label and a complete physical description of the soil sample, including texture, color (including notation of soil mottling), consistency, moisture content, cementation, and structure.

10.1.3 Chain of Custody

Use the chain-of-custody form to document the types and numbers of soil samples collected and logged. Refer to E & E's SOP for Sample Packaging and Shipping (see ENV 3.16) for directions on filling out this form.

10.2 Sampling Design

1. Sampling situations vary widely; thus, no universal sampling procedure can be recommended. However, a Sampling Plan should be implemented before any sampling operation is attempted, with attention paid to contaminant type and potential concentration variations.

2. Any of the sampling methods described here should allow a representative soil sample to be obtained, if the Sampling Plan is properly designed.

3. Consideration must also be given to the collection of a sample representative of all horizons present in the soil. Selection of the proper sampler will facilitate this procedure.

4. A stringent QA Project Plan should be outlined before any sampling operation is attempted. This should include, but not be limited to, properly cleaned samplers and sample containers, appropriate sample collection procedures, chain-of-custody procedures, and QA/QC samples.

11. Data Validation

The data generated will be reviewed according to the QA/QC considerations that are identified in Section 10.

11.1 Quality Assurance/Quality Control Samples

QA/QC samples are used to identify error due to sampling and/or analytical methodologies and chain-of-custody procedures.

11.1.1 Field Duplicates (Replicates)

Field duplicates are collected from one location and treated as separate samples throughout the sample handling and analytical processes. These samples are used to assess total error for critical samples with contaminant concentrations near the action level.

11.1.2 Collocated Samples

Collocated samples are generally collected 1.5 to 3.0 feet away from selected field samples to determine both local soil and contaminant variations on site. These samples are used to evaluate site variation within the immediate vicinity of sample collection.

11.1.3 Background Samples

Background or "clean" samples are collected from an area upgradient from the contamination area and representative of the typical conditions. These samples provide a standard for comparison of on-site contaminant concentration levels.

11.1.4 Rinsate (Equipment) Blanks

Rinsate blanks are collected by pouring analyte-free water (i.e., laboratory de-ionized water) on decontaminated sampling equipment to test for residual contamination. These samples are used to assess potential cross contamination due to improper decontamination procedures.

11.1.5 Performance Evaluation Samples

Performance evaluation samples are generally prepared by a third party, using a quantity of analyte(s) known to the preparer but unknown to the laboratory. The percentage of analyte(s) identified in the sample is used to evaluate laboratory procedural error.

11.1.6 Matrix Spike/Matrix Spike Duplicates (MS/MSDs)

MS/MSD samples are spiked in the laboratory with a known quantity of analyte(s) to confirm percent recoveries. They are primarily used to check sample matrix interferences.

11.1.7 Field Blanks

Field blanks are prepared in the field with certified clean sand, soil, or water. These samples are used to evaluate contamination error associated with sampling methodology and laboratory procedures.

11.1.8 Trip Blanks

Trip blanks are prepared prior to going into the field using certified clean sand, soil, or water. These samples are used to assess error associated with sampling methodology and analytical procedures for volatile organics.

12. Health and Safety

12.1 Hazards Associated with On-Site Contaminants

Depending on site-specific contaminants, various protective programs must be implemented prior to soil sampling. The site Health and Safety Plan should be reviewed with specific emphasis placed on a protection program planned for direct-contact tasks. Standard safe operating practices should be followed, including minimization of contact with potential contaminants in both the vapor phase and solid matrix by using both respirators and disposable clothing.

Use appropriate safe work practices for the type of contaminant expected (or determined from previous sampling efforts):

- Particulate or Metals Contaminants
  - Avoid skin contact with, and ingestion of, soils and dusts.
  - Use protective gloves.

- Volatile Organic Contaminants
  - Pre-survey the site with an HNu 101 or OVA 128 prior to collecting soil samples.
  - If monitoring results indicate organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

13. References

ASTM D 1586-67 (reapproved 1974), ASTM Committee on Standards, Philadelphia, PA.

ASTM D 1586-84, Penetration Test and Split Barrel Sampling of Soils.

Barth, D. S. and B. J. Mason, 1984, *Soil Sampling Quality Assurance User's Guide*, EPA-600/4-84-043.

de Vera, E. R., B. P. Simmons, R. D. Stephen, and D. L. Storm, 1980, *Samplers and Sampling Procedures for Hazardous Waste Streams*, EPA-600/2-80-018.

Ecology and Environment, Inc., 1990, *Standard Operating Procedures*: "Equipment Decontamination," and "Sample Packaging and Shipping."

Mason, B. J., 1983, *Preparation of Soil Sampling Protocol: Technique and Strategies*, EPA-600/4-83-020.

U.S. Environmental Protection Agency (EPA), 1984, *Characterization of Hazardous Waste Sites – A Methods Manual: Volume II, Available Sampling Methods*, (2nd ed.), 1984, EPA-600/4-84-076.

__________, 1991, *Removal Program Representative Sampling Guidance: Volume I – Soil*, (Interim Final), EPA-9360.4-10.

__________, 1984, *Characterization of Hazardous Waste Sites – A Methods Manual: Volume I, Site Investigations*, Section 7: Environmental Monitoring Systems Laboratory, Las Vegas, Nevada, EPA/600/4-84/075.

__________, February 1989, *Methods for Evaluating the Attainment of Cleanup Standards: Volume I, Soils and Solid Media*, EPA/230/02-89/042.

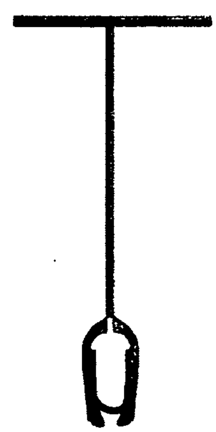
A SAMPLING AUGERS

A. Sampling Augers

(a)
Ship Auger

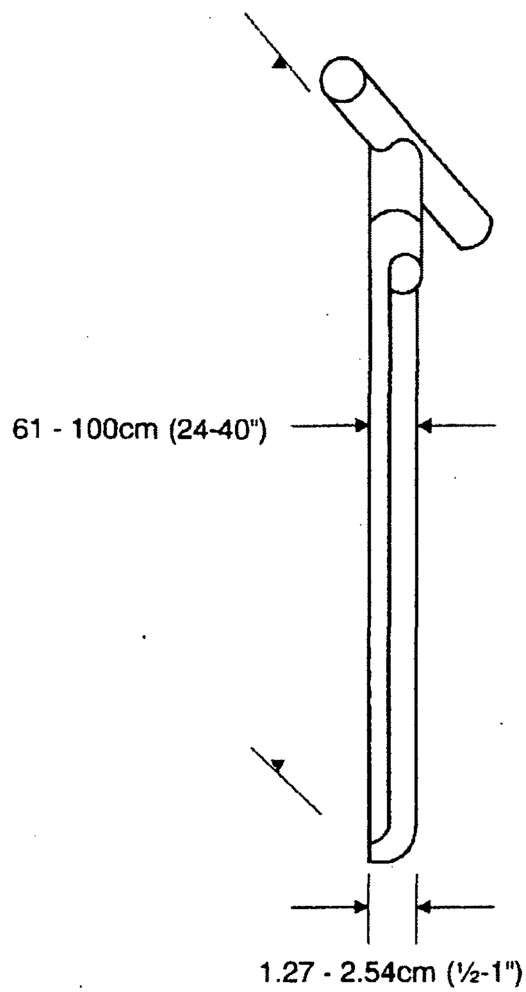
(b)
Closed-Spiral Auger

(c)
Open-Spiral Auger

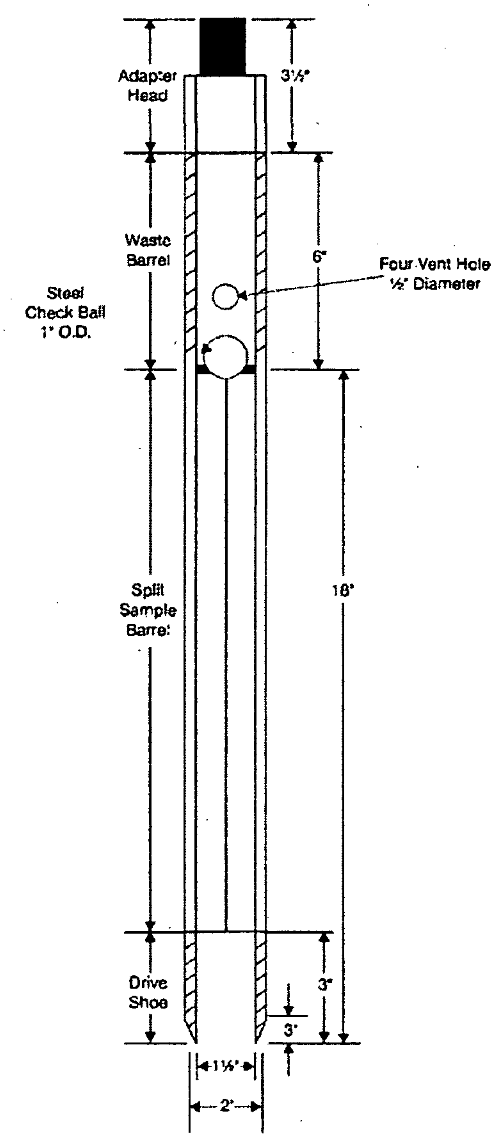


(d)
Iwan Auger

B SAMPLING TRIER



C SPLIT-SPOON SAMPLER



Title:	MEASURING WATER LEVEL AND WELL DEPTH
Category:	GEO 4.15
Revised:	March 1998

STANDARD OPERATING PROCEDURE

MEASURING WATER LEVEL AND WELL DEPTH

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TITLE:	MEASURING WATER LEVEL AND WELL DEPTH		
CATEGORY:	GEO 4.15	REVISED:	March 1998

TABLE OF CONTENTS

Section | Page

1. Introduction

This document describes E & E's standard operating procedure (SOP) for measuring water level and well depth in monitoring wells and piezometers.

2. Equipment

The following is a list of equipment and items typically used for measuring water level and well depth:

- Electronic water level indicator with graduated cable measured at increments of 0.1 and 0.01 foot;
- Plastic sheeting; and
- Folding ruler or pocket steel tape.

3. Procedure

3.1 Preliminary Steps

1. Locate the well or piezometer and verify its position on the site map. Record whether positive identification was obtained, including the well number and any identifying marks or codes contained on the well casing or protective casing. Gain access to the top of the well casing and note the date and time the well was opened. If specified in the work plan or site health and safety plan, use monitoring equipment to measure or take readings of the well headspace. Record all measurements and observations (e.g., odor).

2. Locate and record the specified benchmark or survey point for the well or piezometer, which may be a mark at the top of the casing or a surveyor's pin embedded in the protective structure. Determine the elevation of this point from the records and record in the notebook. Measure and record the vertical distance from the benchmark to the top of the well casing to the nearest 0.01 foot. Measure and record the metal casing stickup (i.e., the distance between the top of the casing and nominal ground level).

3. Record any observations and remarks regarding the completion characteristics and well condition, including evidence of cracked casing or surface seals, security of the well (locked cap), and evidence of tampering.

4. Keep all equipment and supplies protected from contamination with clean plastic sheeting. Keep the water level indicator probe in its protective case when not in use.

3.2 Operation

1. Remove the water level indicator probe from the case, turn on the sounder, and test-check the battery and sensitivity scale by pushing the red button. Adjust the sensitivity scale until you can hear the buzzer and see the red indicator light.

2. Slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering until the meter buzzes. Raise and lower the probe very slowly until the meter begins to buzz continuously. Mark the spot by grasping the cable with the thumb and forefingers at the top of the casing, withdraw the cable, and record the depth.

3. To measure the total well or piezometer depth, lower the probe until slack is felt in the cable. Very slowly raise and lower the cable until the exact bottom of the well is detected. As before, grasp the cable with the thumb and forefinger at the top of the casing and note the depth. If a water level probe, such as the Solinst, is used to measure total depth, the weight of the probe will likely extend approximately 6 centimeters beyond the calibrated "zero" point of the measuring cable. If this is the case, use the cable to accurately measure the distance from the end of the weight to the point of the needle (in the "window" of the probe) and add this length to the depth noted above. Record the sum of these two lengths as the total depth of the well.

4. Withdraw the cable and probe, and decontaminate according to the SOP for Equipment Decontamination (ENV 3.15).

3.3 Data Recording and Manipulation

Record the following computations:

- Casing elevation = bench mark elevation + casing stickup
- Water level elevation = casing elevation - depth of water
- Well bottom elevation = casing elevation - depth to bottom
- Total well depth = cable-measured depth + length of the weight extension

4. Calibration

No calibration is needed for the electronic water level indicator.

5. Precautions

Because some casings have rough or sharp edges, use caution when lowering and retrieving the water level cable from within the well casing. These edges can cut and scrape the cable, obscuring the calibrated markings on the cable, and can eventually lead to failure (shorting out) of the electronic cable.

Always use caution when opening capped wells, because escaping (venting) headspace gases may be hazardous.

C Supplemental Forms

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10

CUSTODY SEAL

Date:	
Signature:	

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10

EPA

USEPA Contract Laboratory Program
Inorganic Traffic Report & Chain of Custody Record

1. Case No.:

DAS No.:

R

2. Region:	3. Date Shipped:	4. Chain of Custody Record	Sampler Signature:
Project Code:	Carrier Name:	Relinquished By: (Date/Time)	Received By: (Date/Time)
Account Code:	Airbill:	1)	
CERCLIS ID:	Shipped To:	2)	
Spill ID:		3)	
Site Name/State:		4)	
Project Leader:			
Action:			
Sampling Co.:			

5. INORGANIC SAMPLE No.	6. MATRIX/ SAMPLER	7. TYPE	8. ANALYSIS/ TURNAROUND	9. TAG No./ PRESERVATIVE/Bottles	10. STATION LOCATION	11. SAMPLE COLLECT DATE/TIME	12. ORGANIC SAMPLE No.	13. QC Type

14. Shipment for Case Complete?	15. Sample(s) to be used for laboratory QC:	16. Additional Sampler Signature(s):	17. Chain of Custody Seal Number:
18. Analysis Key:	**Type:** Comp, Grab (from Box 7)		19. Shipment Iced?

20. TR Number:

PR provides preliminary results. Requests for preliminary results will increase analytical costs.

Send Copy to: Sample Management Office, 2000 Edmund Halley Dr., Reston, VA 20191-3400 Phone 703/264-9348 Fax 703/264-9222

REGION COPY

10/02

USEPA Contract Laboratory Program
Organic Traffic Report & Chain of Custody Record

1. Case No.:
DAS No.:

R

2. Region:	3. Date Shipped:	4. Chain of Custody Record	Sampler Signature:
Project Code:	Carrier Name:	Relinquished By: (Date/Time)	Received By: (Date/Time)
Account Code:	Airbill:	1)	
CERCLIS ID:	Shipped To:	2)	
Spill ID:		3)	
Site Name/State:		4)	
Project Leader:			
Action:			
Sampling Co.:			

5. ORGANIC SAMPLE No.	6. MATRIX/ SAMPLER	7. TYPE	8. ANALYSIS/ TURNAROUND	9. TAG No./ PRESERVATIVE/Bottles	10. STATION LOCATION	11. SAMPLE COLLECT DATE/TIME	12. INORGANIC SAMPLE No.	13. QC Type

14. Shipment for Case Complete?	15. Sample(s) to be used for laboratory QC:	16. Additional Sampler Signature(s):	17. Chain of Custody Seal Number:
18. Analysis Key:	Type: Comp, Grab (from Box 7)		19. Shipment Iced? ________

20. TR Number:

PR provides preliminary results. Requests for preliminary results will increase analytical costs.
Send Copy to: Sample Management Office, 2000 Edmund Halley Dr., Reston, VA 20191-3400 Phone 703/264-9348 Fax 703/264-9222

REGION COPY

D

Sample Plan Alteration Form

SAMPLE PLAN ALTERATION FORM

Project Name and Number: ____

____

____

Material to be Sampled: ____

____

____

Measurement Parameters: ____

____

____

Standard Procedure for Field Collection & Laboratory Analysis (cite references): ____________

____

____

____

Reason for Change in Field Procedure of Analytical Variation: ________________________

____

____

Variation from Field or Analytical Procedure: ____________________________

____

____

Special Equipment, Materials, or Personnel Required: ________________________

____

____

____

CONTACT	APPROVED SIGNATURE	DATE
Initiator:		
START PL:		
EPA TM:		
EPA QA Officer:		